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MATERIALS SCIENCE AND METALLURGY

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ANALYSIS AND TESTING

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THE OPTICAL CONDUCTIVITY OF DISORDERED Cr--Al ALLOYS

Moscow FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 61, No 1, Jan 86
(manuscript received 22 Jan 85) pp 59-63

[Article by L. V. Nomerovannaya, V. A. Rassokhin and N. A. Popova, Metal Physics Institute, Ural Scientific Center, USSR Academy of Sciences]

[Abstract] The optical properties of Cr--Al alloys that had critical concentrations of aluminum, a sharp increase in electrical resistivity, and a negative temperature coefficient were measured polarimetrically. The frequency dispersion of the optical conductivity and of the permittivity of alloys with 12, 16, 18, and 26 at.% aluminum was studied in order to establish the peculiarities of the electron structure responsible for anomalies in the physical properties of these alloys. The refractive and absorptive indices were measured within a spectral range of 0.077--5.0 eV using the Bitty method. The alloys were smelted from 99.99% pure electrolytic chrome and 99.999% especially pure aluminum in an induction furnace and hardened in a copper water-cooled hearth. All of the alloys had positive permittivity in the infrared range with the exception of the 12 at.% alloy, which had negative permittivity. Thus, the anomoly in the value for the temperature coefficient of resistivity precisely coincides with the anomaly in the value for permittivity in the infrared region when these two values are evaluated as a function of the concentration of aluminum in the alloy. Qualitative and quantitative analyses of the optical data confirmed that there are practically no free states in Cr--Al alloys with critical concentrations of aluminum. The low-frequency drop in optical conductivity is completely absent in the far infrared range as frequency increases. With 12 at.% aluminum, the states display the same longevity and absorption pattern as the states of 1 at.% Al. With higher concentrations of Al, the life-span of these localized states begins to decrease, and the relaxation blurring of the optical spectrum recurs. These findings are consistent with the anomalous behavior of the electrical resistivity. References 9: 6 Russian, 3 Western.

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ANISOTROPY IN OPTICAL ABSORPTION IN MONOCRYSTALLIC ERBIUM AND THULIUM

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(manuscript received 25 Jan 85) pp 64-68

[Article by Yu. V. Knyazev and G. A. Bolotin, Metal Institute Physics, Ural Scientific Center, USSR Academy of Sciences]

[Abstract] The optical properties of single crystals of erbium and thulium during the polarization of an electrical light wave vector lengthwise and perpendicular to a hexagonal axis were studied. The measurements were taken at 78 and 293 K. The light quantum energy levels were 0.2--5.6 eV for the erbium and 0.3--5.6 eV for the thulium. The components of the photoconductivity tensor were determined with the Kramers--Kronig integral correlations. The refractive and absorptive indices were measured and used to compute the frequency dispersion of optical conductivity along the hexagonal axis and in the basal plane. In the erbium crystals, the lengthwise component had two maximums, at 1.8 and 2.4 eV, caused by interzonal quantum transitions. In the perpendicular component, an increase in conductivity that was not seen in the lengthwise component was manifested in the low-energy decline in the band (0.9-1.3 eV). The broad peak, at 2 eV, was localized at energies corresponding to the twin-peak structure of the lengthwise component. In both cases, increasing the temperature expanded the range of quantum absorption and somewhat mitigated the contrast between the two components. The anisotropy in the erbium was attributed to the actual difference in the probabilities of the interzonal transitions. Lowering the temperature to 78 K led to the appearance of a low-energy peak at 0.3 eV associated with the transition of the erbium into anti-ferromagnetic state of the "lengthwise spin wave" type. Concerning the thulium, the lengthwise and perpendicular components of photoconductivity had two broad peaks: at 1.9 and 2.8 eV for the lengthwise component, and 1.6 and 2.6 eV for the perpendicular. The peaks were more pronounced at the lower temperature. The mathematical difference between the lengthwise and perpendicular components of the permittivity served as a measure of the anisotropy of the optical properties. The photoconductivity of Er and Tm were similar in regard to the breadth and energy disposition of the quantum absorption peaks. References 10: 3 Russian, 7 Western.

13050/12955
CSO: 1842/150

UDC 669.15'24'25:620.186.1

CHANGE IN THE FINE STRUCTURE AND IN THE LOCAL ATOMIC CONFIGURATION OF ELINVAR ALLOYS BASED ON Ni--Fe--Co

Moscow FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 61, No 1, Jan 86
(manuscript received 04 Dec 84, in final version 08 Apr 85) pp 69-73

[Article by Ye. N. Vlasova, V. I. Matorin, V. S. Zasimov and A. V. Gavrilova, Precision Alloys Institute, Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin]

[Abstract] The structural transformations in high-temperature elinvar Ni--Fe--Co alloys alloyed with Co, Ti, and Al were studied. X-ray crystallography, electron microscopy, and Mossbauer spectroscopy were used. The equipment used included a BS-540 illuminating electron microscope, a YaGR spectrometer made by ELSCINT, and a Nova-1200 mini-computer. Both mono- and polycrystals were examined. These alloys were characterized by the formation of an ordered $L1_2$ -type γ' -phase and a phase with an bcc structure based on CoFe. The latter phase exhibited a B2-type ordering process. The number of structural defects in the alloy was found to determine the γ -- γ' transformation mechanism. The number of α -phases formed tempering was determined by the original state of the alloy, and the relative proportion could be as high as 50%. The formation of the α -phase was accompanied by an additional peak on the probability distribution of effective fields dependence at large values for the effective fields. In the quenched state, the formation of the close-range order of the $L1_2$ phase was accompanied by a contraction in the effective fields probability distribution curve for the Fe nuclei and by an increase in the average value of the effective fields. The Fe atoms were located on the Ti and Al sub-lattice, the elements of which were completely removed from the first Fe coordinating sphere. In a state of equilibrium, the γ' -phase does not contain iron, but the bcc phase is an ordering phase based on carbon and iron. References 4: all Russian.

13050/12955
CSO: 1842/150

UDC 669.017.3:669.1'74:621.762

PHASE TRANSFORMATIONS IN POWDERED Fe-Mn ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 2, Feb 86 pp 23-26

[Article by T. F. Volynova and I. B. Medov, Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin]

[Abstract] The martensitic transformations and the mechanism of structural formation in powdered Fe-Mn alloys was studied. The powders were obtained through melt atomization and contained between 4 and 40% manganese. Hot extrusion was used to compact the powders. Specimens for analysis were cut from the compacted bars. X-ray diffraction analysis on a DRON-1,5 was used to study the phase composition. Metallographic analysis was done on a Neofot microscope and dilatometric analysis on a LEITZ dilatometer. Powdered alloys, like casting alloys, can be divided into four groups according to the concentration intervals of phase transformation: α ; $\alpha+\gamma$ and $\alpha+\gamma+\epsilon$; $\gamma+\epsilon$; and γ . The points marking the start and termination of martensitic transformation differed for the two types of alloys, and the phase formation boundaries in powdered alloys shifted towards a higher concentration of manganese. In powdered alloys, the α - phase exists over a wider range of manganese concentrations -- up to 20 to 23%. Phase distribution was as follows: up to 11.5% Mn -- α - phase; up to 13.5% Mn -- $\alpha+\gamma$ -phases; up to 16.5% Mn -- $\alpha+\epsilon+\gamma$ -phases; up to 35% Mn -- $\gamma+\epsilon$ -phases; and more than 35% Mn -- γ - phase. The mechanism of α - and ϵ -phases was similar for both types of alloys. The maximum number of ϵ -martensite (60%) appeared in alloys with 21% Mn. References 8: 6 Russian, 2 Western.

13050/12955
CSO: 1842/147

UDC 621.762:669.14.018.252

THE EFFECT OF MOLYBDENUM AND VANADIUM ON THE STRUCTURE AND PROPERTIES OF
POWDERED TUNGSTENLESS HIGH-SPEED STEEL

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 2,
Feb 86 pp 26-30

[Article by A. P. Gulyayev and L. P. Sergiyenko, Central Scientific Research
Institute of Ferrous Metallurgy imeni I. P. Bardin]

[Abstract] Changes in the properties of low-alloy powdered high-speed steels when molybdenum and vanadium content were varied were studied. The steels were obtained through nitrogen atomization and then compacted by hot extrusion. Molybdenum content varied between 2.9 and 5.7%, and vanadium content between 2.5 and 4.6%. Carbon content was varied according to the content of the alloying elements, especially vanadium. The microstructure of the steels after annealing was manifested as a sorbite-shaped pearlite with carbide inclusions. Increasing the molybdenum concentration resulted in a larger carbide size, while higher vanadium content had practically no effect. Increasing molybdenum and vanadium content led to increases in carbides, with 5.7% Mo steel having the most. Increasing the quenching temperature and the molybdenum content caused significant growth in the austenitic grain size and extreme embrittlement of the steel. At the optimum quenching temperature (1200°), higher vanadium content results in greater hardness, while higher molybdenum content has little effect. Increasing vanadium content to 4.6% inhibits the growth of austenitic grain size and ensures a fine-grain structure. Molybdenum and vanadium concentrations higher than 3% do not effect thermal stability. The bending strength of the steel drops as molybdenum concentration rises. Impact strength was unaffected by the variations.

References 9: 7 Russian, 2 Western.

13050/12955
CSO: 1842/147

UDC 546.48'289'221

STRUCTURE OF Cd_4GeS_6 FILMS

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 3, Mar 86
(manuscript received 20 Jun 84) pp 381-383

[Article by V. P. Svitlinets, N. I. Dovgoshey, B. V. Anikeyev and V. P. Ivanitskiy, Uzhgorod State University]

[Abstract] Build-up and structurization of Cd_4GeS_6 films by two sputtering methods was studied, vapor deposition of such films being problematic because of the attendant dissociation process. Films produced by both methods, discrete thermal sputtering and laser pulse sputtering, were examined under a UEMV-100K transmission electron microscope. Films produced by thermal sputtering, with both substrate temperature and condensation rate varied, were found to be amorphous or polycrystalline depending on the substrate temperature. Amorphous films were found to build up on substrates at temperatures below 570 K, regardless of the condensation rate. Polycrystalline films were found to build up on substrates at temperatures above 580 K, most distinctly at low condensation rates. Transition from one form to another occurs smoothly over a blurred temperature range, which is attributable to changes in physical properties as well as to gradual coalescence of particles. Sputtering by a YAG laser under vacuum was found to produce essentially amorphous films, but with a transition through and possible retention of a subcooled liquid phase in the form of either a continuous interlayer or droplets. References 10: 7 Russian, 3 Western.

2415/12955
CSO: 1842/192

UDC 546.882.5'34:548.55

ELASTIC, PIEZOELECTRIC, DIELECTRIC PROPERTIES AND THERMAL EXPANSION OF
 Li_2GeO_3 IN 62-600 K TEMPERATURE RANGE

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 3, Mar 86
(manuscript received 21 Jun 84) pp 450-455

[Article by Ye. F. Tokarev, I. A. Dankov, V. I. Ivannikov, A. V. Solodukhin
and M. D. Volnyanskiy, All-Union Scientific Research Institute of Physico-
technical and Radiotechnical Measurements]

[Abstract] Comprehensive measurements of the properties of Li_2GeO_3 were made over the 62-600 K temperature range for the purpose of supplementing and extending the meager presently available data. Specimens for these measurements were cut from single crystals produced by the Czochralski method without subsequent heat treatment and doping. These crystals, in the right-hand 2mm group, are characterized by nine elastic constants, five piezoelectric constants, three dielectric constants, and three thermal expansion coefficients. Their elastic constants and electromechanical coupling coefficients were measured by the resonance-antiresonance method. Their dielectric constants were determined from capacitance measurements at a frequency of 1 kHz. Their thermal exapnsion coefficients were measured in a quartz reference dilatometer. The temperature dependence of all constants and coefficients was determined in a cryostat under vacuum (pressure 1 Pa) over the 62-300 K range and in a muffle furnace with an inert gas (helium) under atmospheric pressure over the 300-600K range, each measurement made with the temperature maintained constant within 0.01 K or 0.5 K respectively and all measurement made in darkness. References 12: 5 Russian, 7 Western (1 in Russian translation).

2415/12955
CSO; 1842/192

UDC 546.87.3'284:66.046.522

OPTICAL ABSORPTION IN $\text{Bi}_{12}\text{SiO}_{20}$ SINGLE CRYSTALS DOPED WITH CHROMIUM OR NICKEL

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 3, Mar 86
(manuscript received 29 Jun 84) pp 507-508

[Article by V. M. Orlov, M. V. Shilova and Ye. Ye. Kolosov, Gorkiy State University imeni N. I. Lobachevskiy and Gorkiy Research Physical Technical Institute]

[Abstract] A study was made of optical absorption in intrinsic $\text{Bi}_{12}\text{SiO}_{20}$ single crystals as well as Cr-doped ones (0.01 wt.% and, 0.1 wt.%) and in Ni-doped ones (0.1 wt.%) at room temperature over the 0.4-1.2 μm range of wavelengths for the purpose of measuring the photochromic effect and the energy of impurity levels. Specimens of such crystals were grown by the Czochralski method. The absorption coefficient was determined from transmission measurements at two thicknesses of the same specimen. The transmission spectrum was determined with an SF-4 spectrophotometer. The photochromic effect was measured using ultraviolet radiation from a mercury-arc lamp for 10 min and radiation at 0.63 μm wavelength and from an He-Ne laser for 10 min, specimens then being annealed in air at a temperature of 470 K for 30 min and subsequently held at room temperature in air in darkness for 3 days. The results for crystals with 0.01% Cr reveal a relaxation of transmission in time, down to some eventually constant level, this process being characterized by two different time constants. The transmission saturation level after 3 days in darkness did not reach the initial transmission level without the crystal being annealed. The photochromic effect, is therefore, retarded by this relaxation and the degree of optical excitation is a function of time elapsed after irradiation. References 6: 5 Russian, 1 Western.

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CSO: 1842/192

UDC 546.873'241

DETERMINATION OF IODINE IN Bi_2Te_3 -BASE ALLOYS BY X-RAY SPECTRAL MICROANALYSIS

MOSCOW NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 3, Mar 86
(manuscript received 26 Dec 83) pp 516-517

[Article by Ye. V. Kulbachevskaya, T. Ye. Svechnikova and S. N. Chizhevskaya,
Metallurgy Institute imeni A. A. Baykov]

[Abstract] A procedure has been developed for quantitative determination of iodine in single crystals of I-doped Bi_2Te_3 and its alloys. Single crystals for such a determination were grown by the Czochralski method with the liquid phase replenished from a floating crucible, which ensured a uniform distribution of host material and dopant. After injection of SbI_3 , the iodine concentration was determined on the basis of the $\text{I L}_{\alpha 1}$ line in an MS-46 microanalyzer under an accelerating voltage of 20 kV. SbSI has been selected as reference standard, because in an electron beam it is chemically least unstable of all bismuth and antimony chalcocides. The effect of nonhomogeneity is minimized by scanning a $100 \times 100 \mu\text{m}^2$ large zone in a period of 400 s. Stray iodine is determined from readings taken with intrinsic Bi_2Te_3 single crystals. The sensitivity of this method is 0.01 wt.% I and the analysis is accurate within 15%. Measurements made using modified Lenard coefficients, with Philibert correction for absorption and atomic numbers as well as Reed correction for fluorescence, indicate that a change in iodine content from 0.08 to 0.12 wt.% has an appreciable effect on the electrophysical properties of Bi_2Te_3 . References 6: 3 Russian, 3 Western.

2415/12955
CSO: 1842/192

UDC 541.133:546.654-31'713-31

ELECTRICAL PROPERTIES OF Pb-DOPED LaMnO_3

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 3, Mar 86
(manuscript received 28 Nov 83) pp 522-524

[Article by P. P. Zhuk, A. A. Vecher and V. V. Samokhval, Belorussian State University imeni V. I. Lenin and Scientific Research Institute of Physical Problems Chemistry]

[Abstract] A study of polycrystalline LaMnO_3 as electrode material for use with solid electrolyte and for monitoring the fuel combustion in internal-combustion engines was made, the purpose being to determine the effect of PbO additive from $(\text{C}_2\text{H}_5)_4\text{Pb}$ on the electrical properties. Specimens were produced by mixing 99.9% pure La_2O_3 with extra-pure PbO and Mn_2O_3 after thorough pulverization of all ingredients. Solid-state reactions in air at a temperature of 1200-1300 K for 20-30 h, depending on the mix ratio, yielded $\text{La}_{1-x}\text{Pb}_x\text{MnO}_3$ solid solutions. After x-ray phase analysis in a DRON-3 diffractometer at room temperature, powders of four of these materials, with $x = 0$ (LaMnO_3), 0.1, 0.2, 0.5 respectively, were compacted into 50 mm long $4 \times 4 \text{ mm}^2$ square bars under a pressure of approximately 15 MPa and sintered at a temperature of 1200-1400 K for 2-5 h depending on the composition. The density of the materials was measured by the picnometric method with n-butanol at 298 K. The electrical conductivity of compact bars as well as of layers deposited on $\text{Zr}_{0.87}\text{Y}_{0.13}\text{O}_{1.935}$ solid electrolyte and then sintered at a temperature of 1650-1700 K for 1-1.5 h was measured by the four-probe method with direct current over the 298-1273 K temperature range during heating at a rate of 5 K/min and during cooling. With the temperature dependence of electrical conductivity describable by the relation $\sigma = AT^{-1}e^{-E/RT}$, doping with Pb does not alter this semiconductor characteristic but only changes the magnitude of the electrical conductivity and especially so at room temperature. The electrical conductivity is maximum with $x = 0.2$ ($\text{La}_{0.8}\text{Pb}_{0.2}\text{MnO}_3$). The electrical resistance parameter, the ratio of electrical resistivity of electrode material to thickness of electrode layer, decreases with increasing electrode layer thickness but remains higher than that ratio for compact bars of the same material. This indicates a high porosity of a $\text{La}_{0.8}\text{Pb}_{0.2}\text{MnO}_3$ electrode layer sintered onto a solid electrolyte and, consequently, a favorably shorter response time and lower limit of the operating temperature limit for such an electrode. References 8: all Western.

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CSO: 1842/192

UDC 620.179.16

EQUIPMENT AND PROCEDURE AVAILABLE FOR CALIBRATING PIEZOELECTRIC RECEIVER
TRANSDUCERS BY RECIPROCITY METHOD

Sverdlovsk DEFEKTOSKOPIYA in Russian No 3, Mar 86
(manuscript received 18 Aug 84, in final version 4 Feb 85) pp 23-28

[Article by M. V. Geller, All-Union Scientific Research Institute of Non-destructive Means of Testing Quality of Materials, Kishinev]

[Abstract] A procedure is proposed for calibrating piezoelectric acoustic-emission transducers on the basis of the reciprocity theorem and with standard commercial equipment to measure the amplitude-frequency characteristics of fourpole networks. A tracking signal with sawtooth frequency variation is most suitable for this purpose, making it possible to tune out reflected and transformed sound waves, particularly when used with an SK4-59 or Kh1-46 instrument not requiring a correction for diffraction under a matched acoustic load. Appropriate electric circuitry, with standard components, is needed for eliminating velocity or displacement distortions in the amplitude-frequency characteristic on the electric side obtained by velocity or displacement conversion respectively. The procedure and equipment are adaptable to calibration for volume acoustic waves and surface acoustic waves.

References 7: 3 Russian, 4 Western (1 in Russian translation).

2415/12955
CSO: 1842/196

UDC 620.179.16

DEPENDENCE OF ACOUSTIC-EMISSION PARAMETERS ON DIMENSIONS OF MICROCRACKS AND
ON STRUCTURE OF DEFORMED ROTOR STEEL

Sverdlovsk DEFEKTOSKOPIYA in Russian No 3, Mar 86
(manuscript received 7 Feb 84, in final version 26 Jun 85) pp 41-44

[Article by Ye. Yu. Nefedyev, V. A. Volkov, S. V. Kudryashov, A. I. Lyashkov
and V. N. Savelyev, Physical Technical Institute imeni A. F. Ioffe, USSR
Academy of Sciences]

[Abstract] A study of acoustic emission in rotor steel with a tempered bainite structure was made, for the purpose of establishing the dependence of the signal parameters on the dimensions of microcracks and on the geometrical characteristics of that structure. A specimen with polished upper surface, for metallographic examination, was loaded with a water tank so heavy as to eliminate acoustic noise and the pressure was increased linearly at a rate of 0.32 MPa/s. Acoustic emission signals were recorded by a Dunegan/Endevco series 3000 instrument with a D-9202 transducer (passband 0.1-2 MHz, feed-through channel gain 90 dB, noise level referred to input side not exceeding 5 μ V). The distribution of microcrack sizes was determined from length measurements under a PSEM-500 microscope. This distribution coincides with the log normal distribution of bainite grain sizes (most likely grain size 25 μ m) in the upper range and of bainite comminuting packet sizes (most likely packet size 6 μ m) in the lower range, these log normal distributions being based on metallographic analysis by the method of chords. The distribution of microcrack sizes correlates with the distribution of acoustic emission pulse amplitudes, with a 0.988 correlation coefficient according to the expression $A = 10^{-1.62} L^{1.42}$ (A - amplitude of acoustic emission spikes, L - length of microcracks). References 6: 5 Russian, 1 Western (in Russian translation).

2415/12955
CSO: 1842/196

UDC 620.179.14

USE OF AUTOMATIC DEMAGNETIZATION FOR NONDESTRUCTIVE INSPECTION

Sverdlovsk DEFEKTOSKOPIYA in Russian No 3, Mar 86
(manuscript received 2 Jan 85, in final version 13 May 85) pp 50-55

[Article by P. P. Astashenko, N. N. Zatsepin, G. A. Mikhaltsevich and
N. I. Ryseykin, Applied Physics Institute, BSSR Academy of Sciences]

[Abstract] Automatic demagnetizing equipment has been developed for coercimeters used in nondestructive inspection of steel, with frequency regulation of the demagnetizing current to match the thickness of inspection samples and the magnetic permeability of their material. The equipment consists of three kipp oscillators, the first one and the third one each closing an optron switch and the latter closing a transistor switch to a demagnetizer across the transducer winding, the second one between the other two providing a time delay. The demagnetizer consists of two parallel diodecapacitor branches in series with the transducer winding on a current-limiting resistor. The automation includes triggers and logic, to ensure passage of an alternating current with exponentially decaying amplitude and increasing cutoff angle. The two main kipp oscillators discharge the capacitors through the magnetizing transducer winding during respective current half-periods. The demagnetizer requires four power supplies: a stabilized +5 V d.c. source, two galvanically isolated ± 15 V d.c. sources, and a 35 V a.c. source. The demagnetizer with complete automation was tested on disk specimens of 30KhGSA steel, 7.5 mm thick and 100 mm in diameter, heat treated by quenching from 850°C in oil and tempered at various temperature for attainment of three different hardness levels and correspondingly different magnitudes of the coercive force: 48 Rockwell C (1.4 kA/m), 25 Rockwell C (0.8 kA/m). It was also tested on specimens of U8 steel, to determine the dependence of the hardness measurement error on the number of alternating-current periods. The optimum number of periods was found to be within the 10-15 range. References 3: all Russian.

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CSO: 1842/196

UDC 620.179.14

MAGNETIC CHARACTERISTICS OF 38KhS STEEL AFTER ISOTHERMAL QUENCHING OF SPECIMENS

Sverdlovsk DEFEKTOSKOPIYA in Russian No 3, Mar 86
(manuscript received 27 Dec 84, in final version 10 Jul 85) pp 61-64

[Article by A. M. Katsevman and V. A. Sandovskiy, Metal Physics Institute, Ural Science Center, USSR Academy of Sciences]

[Abstract] Magnetic properties of 38KhS steel after isothermal quenching are analyzed, for the purpose of correlating these properties with the mechanical ones so as to facilitate nondestructive inspection for controlling the heat treatment. Specimens of this steel with initial ferrite-pearlite structure were produced from three different ladles (0.34-0.41% C, 1.35-1.51% Cr, 0.42-0.55% Mn, 1.10-1.29% Si, 0.020-0.035% P, 0.012-0.018% S) in the form of 200 mm long rods 20 mm in diameter and isothermally heat treated, first in a salt bath for 25 min at $910+10^{\circ}\text{C}$ and then in an alkaline bath for 25 min at various temperatures ranging from 280°C to 400°C in 20°C steps. From each heat treated rod were cut one piece for tension test, two pieces for impact test, a center piece for microstructural examination in a DRON-0.5 x-ray diffractometer with a $\text{CrK}\alpha$ -radiation source, and 10 mm thick toroidal piece with 19.5 mm outside diameter and 9 mm inside diameter for measurement of coercive force and maximum magnetic induction. The correlations of each of these two magnetic characteristics with the heat treatment temperature is inadequate for using any one alone as inspection parameter, because these correlations are influenced by internal stresses, number and size of inclusions, and buildup of magnetization reversal centers in the metal. Both in combination can be used for heat treatment control, after a ladle inspection. Magnetic spectrometry with harmonic analysis is much more expedient. This is demonstrated on eight batches, four accepted and four rejected on the basis of such a nondestructive inspection as well as, for confirmation, on the basis of destructive mechanical impact tests. Only the amplitudes of the third harmonic and the fifth harmonic are needed here for reliable inspection. References 7: 6 Russian, 1 Western (in Russian translation).

2415/12955
CSO: 1842/196

UDC 620.179.15

ELECTRORADIOGRAPHY OF CASTINGS

Svedlovsk DEFEKTOSKOPIYA in Russian No 3, Mar 86
(manuscript received 5 Apr 85) pp 65-68

[Article by Ye. A. Gusev, Scientific Research Introscopy Institute, Moscow]

[Abstract] Nonuniform attenuation of the ionizing radiation beam by castings, whether of ferrous or nonferrous metals and alloys, is the main difficulty in their nondestructive inspection by radiography. Neither compensation techniques nor computer-aided tomography are quite expedient enough remedies. Instead, electroradiography is proposed on account of its high speed as well as high sensitivity. An electroradiographic defectoscope consists of an x-ray machine (RAP-150/300) and an opaque cassette (ERGA-02 electroradiograph) containing an electroradiographic plate (SERP) and an auxiliary electrode inside, with an external high-voltage source connected across them. The electroradiographic plate, 300x400 mm large, consists of a 200 μ m thick selenium photoreceiver film on a metal substrate. The auxiliary electrode is an aluminum one deposited on a dielectric substrate. Operation and performance of this apparatus with a modulating constant electric field are demonstrated on duralumin and St3 steel castings of an intricate shape such as a "staircase" wedge, a casting for inspection being placed between the x-ray machine and the cassette. With the electric field as control mechanism, it is possible to extend the thickness range of inspection for any one x-raying event without lowering the sensitivity. The author thanks A. P. Aleyev and V. V. Krasko for assistance in the experiment and discussion of the results. References 5: all Russian.

2415/12955
CSO: 1842/196

UDC 681.142.353:669.183.4.067

APPLICATION OF THEORY OF STATISTICAL GAMES TO AUTOMATIC CONTROL SYSTEM FOR
ARGON-OXYGEN REFINING PLANT

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in
Russian No 3, Mar 86 (manuscript received 11 Jul 85) pp 126-130

[Article by V. N. Kaplan and O. S. Yereskovskiy, Metalupravtomatika, Dnepropetrovsk Institute Metallurgy]

[Abstract] Software for automatic control of the argon-oxygen steel refining unit at the Dneprpetstal Electrometallurgical Plant has been designed by application of statistical methods. After the first "blow" operation the temperature of the metal is measured and the carbon content in the melt is estimated. With these input data the control computer programs the second "blow" operation. A time lag is involved, because sampling of the metal, transporting the sample to the laboratory, and chemical analysis of the sample require from a few seconds to a few minutes. The results of chemical analysis are fed to the computer through a video terminal so that no time lag is involved here. Estimates of the carbon content made on the basis of a mathematical model of the refining process must be verified through feedback from chemical analysis. A set of strategies is introduced for timing the second "blow" operation. Here the theory of statistical games is applied to selection of the optimum strategy which will minimize the mean losses in process time and equipment wear caused by the time lag in the control loop with feedback from chemical analysis and the probabilistic nature of data input coordination. A numerical example illustrates this concept.

References 3: all Russian.

2415/12955
CSO: 1842/197

UDC 620.193.54:669.295

KINETICS OF OXIDATION OF REFINED TITANIUM IN OXYGEN ATMOSPHERE AT 300-700°C

Leningrad ZHURNAL PRIKLADNOY KHMII in Russian Vol 59, No 3, Mar 86
(manuscript received 14 Dec 84) pp 481-485

[Article by V. I. Dyachkov, Leningrad State University imeni A. A. Zhdanov]

[Abstract] Oxidation of refined titanium was studied at oxygen pressure of 164 mm Hg using a previously reported gravimetric method. Oxidation kinetics obeys the cubic law between 300 and 400°C almost from the beginning of oxidation, whereas at 450-700°C the cubic law takes over after an initial period during which the Evans law or a near-parabolic law is in force. Temperature dependence of oxidation velocity constants and apparent activation energies of oxidation according to cubic, linear, and parabolic laws are reported. References 21: 6 Russian, 15 Western.

12973/12955
CSO: 1842/200

COATINGS

PRODUCTION AND PROPERTIES OF AMORPHOUS METALS DESCRIBED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 15 May 86 p 4

[Article by Ye. Kolesnikova: The Facets of 'Kristall']

[Text] Scientists of the All-Union High-Frequency Currents Scientific Research Institute, in collaboration with specialists of the Central Scientific Research Institute for Ferrous Metallurgy, have created equipment for the production of unusual metallic ribbons.

"Do you know how a gold border is applied on cups and plates?" -- the director of the All-Union High-Frequency Currents Scientific Research Institute, F. Bezmenov, somewhat unexpectedly started our conversation.

"We have had an occasion to see it; it is a simple operation. The painter rapidly rotates the plate, and its edge slides against a stationary paint brush. The border appears literally in a flash."

"Our Kristall-702 works roughly in the same manner. But the border made by it can be easily removed; what remains in the hands is a very thin metallic ribbon made without the traditional metallurgical operations such as forging, stamping or rolling."

We approached the apparatus. Its huge drum rotated rapidly but it appeared to be motionless-- so perfectly polished was its surface. A quartz vessel filled with molten copper was suspended above the drum. I was warned to watch carefully because Kristall works as quick as lightening. But in spite of the warning I missed the moment in which a heavy metallic drop fell from a narrow nozzle onto the smooth disk. At the same moment, not having had enough time to spread, it was transformed into a narrow snake-like copper ribbon. A kilometer length of the finished product came off the drum in half a minute.

"I reckon a day would be sufficient for Kristall to wrap the globe along the equator with this ribbon" -- quipped Feliks Vasilyevich. But the merit of the apparatus lies not only in its high productivity; it produces a new class of metals -- amorphous metals. Already as school children we learn that diamond and graphite are made of the same substance but that they differ by their internal structure. And at high temperatures and pressures graphite is transformed to diamond.

Kristall also changes the internal structure of a substance. When a hot drop falls on a cold drum, it cools at an enormous speed -- millions of degrees per second. It is no wonder that at such a rapidity of the process the metal atoms do not have sufficient time to take their places in the crystal lattice and solidify in disorder, just as in ordinary glass. It is no accident that these materials are called metallic glasses.

Amorphous copper, steel, and aluminum ribbons only several microns thick fool even experienced specialists. Their appearance is no different from that of ordinary metal. They are shiny and cool to the touch. But when viewed in the microscope they are structured like glass.

What is interesting about the new materials? It turns out that they have a rare set of properties. The flexible, hard, and abrasion resistant metallic glasses, with high magnetic properties, will be used for the manufacture of the sound and video equipment heads and will increase the memories of magnetic computer tapes. They are awaited by instrument makers and electrical engineers. Also, if one changes the technology slightly and makes the drum surface not smooth but knurled or honeycombed, one can obtain ribbon with any desired pattern. Amorphous metals can also be compressed into granules; the cutting tools made from them are as strong and corrosion-resistant as those made from alloyed metals.

"And now you can test for yourself one of the new specimens" -- said Feliks Vasilyevich handing me a narrow, shiny ribbon. It bent easily, and, truthfully speaking, it appeared to me as a very simple metallic ribbon.

"You can simply cut it with scissors" -- suggested Bezmenov. "Isn't it so? And only recently such an alloy was simply impossible. It contains one and a half times more of an important component of many present-day alloys -- silicon -- than do the better grades of electrical-sheet steel. In spite of all the attempts of metallurgists and foundrymen, it was impossible to obtain articles with increased silicon content; the billets disintegrated before one's eyes. And this ribbon is ductile. You saw it for yourself. Kristal has freed the material from its previous brittleness. The iron-silicon alloy will reduce the losses by a two-digit factor just in electro-thermics alone. Magnetic cores and transformers will be lighter and more compact, and corrosion will be reduced."

One thing remains to be added. Series production of Kristall equipment at one of the electrothermic equipment plants is intended to begin in the near future.

12973/12955
CSO: 1842/209

UDC 541.135

THE ELECTRODEPOSITION OF LOW-POROSITY SOLID NICKEL COATINGS

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 1, Jan-Feb 86
(manuscript received 24 Dec 84) pp 93-95

[Article by S. I. Berezina, T. D. Keshner, Yu. P. Khodyrev, R. N. Voytsekhovskaya and V. A. Alfonsov, Organic and Physical Chemistry Institute imeni A. Ye. Arbuzov, Kazan Affiliate, USSR Academy of Sciences]

[Abstract] The electrodeposition of nickel from acid sulphate electrolytes was studied. Organic additives containing only phosphorous or silicon in a single molecule and compounds containing both elements in a single molecule were added to the electrolyte. The working solution was an electrolyte containing NiSO_4 (0.85), NiCl_2 (0.15), and H_3BO_3 (0.5) in moles/liter. Microhardness was determined using a PMT-3 to a thickness of 12 mcm. Porosity was determined per state standard to a 3-mcm thickness. Current efficiency was measured with a coulometer. When organic compounds containing both phosphorous and silicon in a single molecule were added to the electrolyte a very hard poreless coating formed on the cathode. This did not happen with the addition of compounds containing only phosphorus or only silicon. The addition of phosphorosilicon organic compounds to an electrolyte of (moles/liter) $\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$ (0.71-0.86), $\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$ (0.10-0.15), and H_3BO_3 (0.40-0.50) at room temperature with pH 3-5 and jk 2-4 A/dm was recommended. Nickel coatings obtained in this manner withstood standard testing. References 7: 6 Russian, 1 Western.

13050/12955
CSO: 1842/154

UDC 621.337.7

THE DEPOSITION OF COMPOSITE IRON COATINGS WITH LINEAR POLYAMIDE ADDITIVES AND
SOME OF THEIR PROPERTIES

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 1, Jan-Feb 86
(manuscript received 29 Jan 85) pp 107-110

[Article by S. A. Pushkareva and I. P. Golovacheva, Ural Department of the
All-Union Scientific Research Institute of Railroad Transport]

[Abstract] The effect of adding linear polyamides to iron coatings was studied. An iron-polyamide coating was deposited onto 30x100 mm steel specimens from an iron-coating electrolyte containing P68 polyamide. The independent variables evaluated were current density, electrolyte temperature, concentration of polyamide additives, and concentration of free hydrochloric acid in the electrolyte. Current efficiency basically depended on the concentration of the polyamide additive. Acidity and temperature had some influence on current efficiency, depending upon their relationship with one another. Current density had virtually no effect on current efficiency (of the iron-polyamide coating). Lowering the temperature of electrolysis had the greatest influence on the composition of the composite coating. X-ray crystallography on a DRON-20 showed that the polyamide particles are mechanically implanted in the iron matrix and are uniformly distributed throughout it. The composite coatings are highly resistant to corrosion and highly elastic. They are less susceptible to brittleness and cracking. Microhardness is somewhat lower, but more stable. The specimens were also tested for durability on an MI-1M friction machine. The composite coating had higher wear resistance and was less likely to be rubbed off through friction. Several tests were done to see how well the coatings adhered to the metal and showed that the coatings had a high degree of adhesion to the steel specimens, with a low incidence of defects. References 3: all Russian.

13050/12955
CSO: 1842/154

UDC 621.793:541.138.3:539.2

THE EFFECT OF PULSE ELECTROLYSIS ON THE STRUCTURE AND PROPERTIES OF RHODIUM COATINGS

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 1, Jan-Feb 86
(manuscript received 11 Mar 85) pp 110-112

[Article by V. I. Kaptanovskiy, V. A. Zabludovskiy and N. A. Kostin,
Denpropetrov Institute of Railroad Transport Engineers]

[Abstract] The effect of the parameters of pulse unipolar current on the structure and properties of rhodium coatings was studied. The electrolyte consisted, in g/l, of rhodium sulphate (8-10, sulfamic acid (8-12), and sulfuric acid (90-100). The pH level was about 1 and, the temperature 18-25°. Average current density varied between 0.2 and 8 A/dm², current density amplitude from 5 to 200 A/dm², pulse duration from 1.2 mcs to 8.6 ms, and pulse repetition frequency from 20 to 10,000 Hz. The coating was 1 to 15 mcm thick. With an increase in frequency, the cathode potential amplitude dropped and the current efficiency of the rhodium increased. The most effective current density amplitude was 20 to 30 A/dm²; higher amplitudes had undesirable results. This amplitude, in conjunction with alternating low- and high-frequency pulses, yielded high-strength rhodium coatings with relatively low internal stresses, no porosity to a thickness of 1 to 2 mcm, and a current efficiency of 18 to 25%. References 5: all Russian.

13050/12955
CSO: 1842/154

UDC 621.3.035.2

USING AN UNDERCOATING OF FeSn_2 ON TITANIUM ANODES WITH OXIDE IRON-PALLADIUM COATINGS

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 1, Jan-Feb 86
(manuscript received 26 Sep 84, after revision 13 Mar 85) pp 139-141

[Article by L. N. Guryeva and N. F. Razina, Organic Catalysis and Electrochemistry Institute, Kazakh SSR Academy of Sciences]

[Abstract] The effectiveness of an undercoating of FeSn_2 in protecting titanium anodes with oxide coatings from oxidation was studied. The alloy was galvanized onto the titanium base. The active iron-palladium oxide coating was obtained through the thermal dissociation at 600° of a mixture of nitric acid solutions of iron and palladium on the titanium base. The optimal thickness of the undercoating was $5 \cdot 10^{-6}$ to $9 \cdot 10^{-7}$. When used as an undercoating, FeSn_2 lowers and stabilizes the potentials of the titanium anodes and prolongs their life. It also increases the anode's resistance to corrosion. It is possible that this alloy can be used as a substitute for rarer and more expensive materials, such as platinum. References 8: 6 Russian, 2 Western.

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CSO: 1842/154

UDC 621.74:669.138

FREEZE-ON OF Fe-Si ALLOYS TO TUBES OF HEAT EXCHANGES

Moscow LITEYNAYE PROIZVODSTVO in Russian No 3, Mar 86 pp 8-9

[Article by A. P. Zhukov, candidate of technical sciences, B. I. Mrochkovskiy, engineer, G. M. Semenov, candidate of technical sciences and N. I. Katsarava, engineer]

[Abstract] Cast iron with high silicon content and consequently high corrosion resistance is eminently suitable for tubes of heat exchangers in large H_2SO_4 manufacturing plants, but such a material is not easily formable into thin tubes of only 2-5 mm wall thickness, typically 40-100 mm in diameter and 1000-2000 mm long. Alloying ferrosilicon with Ni, Cu and Ti, to compensate for the technologically necessary reduction of the Si content with minimum sacrifice of corrosion resistance, and then lining plain steel tubes with the alloy by the freeze-on process so as to form, in effect, bimetal tubing, has been considered. Corrosion tests in a special furnace with automatic temperature regulation, and with 3x20x50 mm³ specimens immersed in an H_2SO_4 medium at high temperatures for up to 180 h, have yielded 1.2% Ni, 1% Cu, 0.6% Ti as the optimum combination. Experimental evaluation and theoretical analysis of the freeze-on process have yielded the optimum melt temperature within the 1200-1260°C range and the optimum melt freeze-on time within the 5-20 s range for producing a 3 mm thick ferrosilicon layer on a steel tube. Experiments have revealed that the lining thickness increases within the first 10 s, at a rate which decreases with increasing melt temperature. The thermophysical model with a system of Fourier second-order differential equations of heat transmission through tube and melt, with Stefan boundary conditions, yields a relation between freeze-on time and melt temperature depending on the thermophysical properties of molten ferrosilicon and solid steel. According to a technology based on the results of this study, tubes were manufactured with experimental-production equipment at the Casting Problems Institute (UkSSR Academy of Sciences) for the H_2SO_4 condenser now satisfactorily operating at the Novopolotsk Petroleum Processing Plant imeni 25th CPSU Congress. The study was conducted under guidance of B. A. Kirihevskiy, candidate of technical sciences, with the participation of engineers N. I. Nazarenko and V. L. Cherkasskiy.

2415/12955
CSO: 1842/194

CORROSION

UDC 620.193.01

THE EFFECT OF HYDROGEN SATURATION ON THE CORROSION PROPERTIES OF AUSTENITIC STAINLESS STEELS

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 1, Jan-Feb 86
(manuscript received 13 Aug 84) pp 39-45

[Article by V. L. Bogoyavlenskiy and V. S. Kropachev]

[Abstract]. The effect of electrolytic hydrogen saturation on various properties of 08Kh18N10T and 03Kh17N15M3 austenitic stainless steels (ANS) with strongly differentiated austenite stabilities was studied. Flat specimens were heat-treated in a vacuum at 1050°, cooled, and electropolished. Some specimens were reduced by 15%. They were then hydrogenated at room temperature in an H_2SO_4 solution with a cathode current density of 150 mA/cm². The specimens were tested for corrosion cracking by bending them and subjecting them to a solution of water and ferric chloride at 360° under equilibrium pressure. The tendency towards intercrystalline corrosion was determined by recording potentiodynamic curves in a ferric chloride solution at 90° and determining potentials from a silver chloride electrode. Mechanical tensile tests were done at 20--300° on a tensile testing machine using flat specimens. Tubular specimens were tested for tensile failure in an electrochemical autoclave. X-ray crystallography was done on a DRON-2.0 diffractometer. The condition of the surface was studied with an UEMV-100K electron microscope using the carbonic replica method. The structure of the metal was studied using an YeM-300 electron microscope. It was found that electrolytic hydrogenation led to the formation of martensitic phases, high stresses, and microcracking in the surface of the metal. Hydrogenation had little effect on the plasticity of deformation-stable austenitic steel as it lowered its strength characteristics when the specimens were mechanically tested at 100--300°. When compared to non-hydrogenated steels, hydrogenated steels had lower passive state persistence and higher anode dissolution current density. The anode process was strengthened due to the migration of bivalent metal ions into the solution. Hydrogenation also had little effect on resistance to chloride corrosion cracking and intercrystalline corrosion.

References 8: 6 Russian, 2 Western.

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CSO: 1842/154

UDC 620.194

HYDROGEN BRITTLENESS AT POSITIVE POTENTIALS DURING THE CORROSION CRACKING OF HIGH-STRENGTH STEELS AND TITANIUM ALLOYS

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 1, Jan-Feb 86
(manuscript received 29 Jun 84, after revision 15 Nov 84) pp 46-53

[Article by V. A. Marichev, Physical Chemistry Institute, USSR Academy of Sciences]

[Abstract] The corrosion cracking of a series of high-strength martensitic steels and VT20 titanium alloy was studied. Specimens 210x 25x2-8 mm with lateral fatigue cracks were subjected to uniaxial tensile testing to determine crack length and crack growth rate (SRT) using continuous electroresistivity measurement. The specimens were tested at room temperature in a solution of chromic anhydride with admixtures of chlorine-and sulfate ions. The effect of cathode polarization on the SRT was studied. The dependence of the values for the critical stress intensity coefficient and critical SRT on the cathode polarization potential was determined. The results showed that hydrogen brittleness occurs in titanium alloys and high strength steels at positive potentials that thermodynamically preclude the electrochemical liberation of hydrogen gas. This, however, does not preclude the discharge of hydrogen ions and the formation of absorbed hydrogen atoms on the surface of the passivating film and their ability to penetrate it and initiate hydrogen brittleness. The discharge of hydrogen ions can be regarded as a possible and important process of cathode depolarization that would lead to the hydrogenation and hydrogen brittleness of the metals during corrosion involving continual surface regeneration. References 17: 3 Russian, 4 Western (2 in Russian translation).

13050/12955
CSO; 1842/154

UDC 620.193.47

MATERIALS FOR MANUFACTURING COMPONENTS USED TO TREAT LOWER CARBOXYLIC ACIDS

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 1, Jan-Feb 86
(manuscript received 28 Nov 84) pp 54-61

[Article by V.-I. D. Zaritskiy]

[Abstract] The corrosion resistance of VSt3, 08Kh13, 08Kh17T, 10Kh14AG15, 10Kh14G14N4T, 08Kh18G8N2T, 08Kh22N6T, 12Kh18N10T, 08Kh21N6M2T, 10Kh17N13M2T, and 10Kh17N13M3T steels, ADO aluminum, AMts aluminum alloy, and VT1-0 titanium was studied. The chemical resistance of rigid PVC plastic, polyethylene, pentaplastic, fluorplastic, butyl rubber, acid-resistant enamel, graphite, and ATM-1 antegmite were also studied. Specimens 20x10x1.0 mm and 40x25x2.0 mm were tested under laboratory conditions designed to simulate the industrial treatment (utilizatsiya) of inferior carboxylic acids. Corrosion was determined by measuring mass and through metallography in the case of the metals, and by measuring mass and evaluating the external appearance of the non-metal specimens. Corrosion resistance was highest in VT1-0, followed by 10Kh17N13M3T, 10Kh17N13M2T, 08Kh21N6M2T, 12Kh18N10T, 08Kh22N6T, 10Kh14G14N4T, 08Kh18G8N2T, 10Kh14AG15, 08Kh17T, and 08Kh13. VT1-0 titanium and 10Kh17N13M3T steel did not exhibit tendencies towards selective corrosion. Under certain conditions, the aluminum and aluminum alloy suffered pitting damage. Of the non-metallic materials, the acid-resistant enamel and the teflon had the broadest range of corrosion-resistance properties. The ATM-1 and graphite impregnated with phenolformaldehyde resins were resistant to certain types of corrosion. The rubber, PVC, and polyethylene showed poor corrosion resistance in some instances. References 15: all Russian.

13050/12955
CSO: 1842/154

UDC 620.193.01

SURFACE CONDITION, CORROSION CRACKING, AND PITTING CORROSION OF 08Kh18N10T
IN A SOLUTION OF $MgCl_2$

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 1, Jan-Feb 86
(manuscript received 12 Dec 85, after revision 04 May 85) pp 114-117

[Article by V. A. Levchenko, A. N. Kuzyukov, Yu. Ya. Nikhayenko and
V. S. Novitskiy, Ukrainian Scientific Research Institute of Chemical Machine
Building, Severodonetsk Branch]

[Abstract] The effect of surface treatment on corrosion cracking and pitting corrosion was studied. Specimens of 08Kh18N10T stainless steel (0.075% C, 1.34% Mn, 0.33% Si, 9.95% Ni, 18.1% Cr, 0.53% Ti), quenched from 1150°, were 1) abraded with emery paper, 2) mechanically polished with diamond paste and chromium oxide, or 3) mechanically polished and pickled in aqua regia. The specimens were tested for corrosion cracking at specific stresses in boiling 42% $MgCl_2$ for 1000 hours and checked every 50 hours. A P-5848 potentiostat was used to measure polarization of specimens in tri-electrode thermostatically controlled cell in an unagitated aerated $MgCl_2$ solution saturated at 40°, with a test temperature of 80°. The pitting and repassivation potentials were also measured potentiostatically. Pitting was determined metallographically, residual stress through x-ray analysis, and surface inclusions on an electron microscope. Specimens with pickled surfaces had the highest resistance to corrosion cracking. Surface conditions had little effect on pitting corrosion and no effect on repassivation potential. Pitting had the strongest tendency to occur on the skin holes arising from the pickling of dislocations. A combination of polishing and pickling in 3% NaCl increased pitting potential by 0.175 V. Higher potentials coupled with large residual stresses led to pitting-induced corrosion cracking. References 8: 7 Russian, 1 Western.

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UDC 620.193.01

THE KINETICS OF HYDROGEN LIBERATION DURING THE INITIAL STAGES OF ALUMINUM CORROSION IN WATER AND NEUTRAL ETHANOL SOLUTIONS

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 1, Jan-Feb 86
(manuscript received 31 Jan 84, after revision 08 Apr 85) pp 126-129

[Article by V. P. Persiantseva, V. Ye. Zorina and M. S. Fedorov, Physical Chemistry Institute, USSR Academy of Sciences]

[Abstract] The corrosion mechanism during the initial stages of dissolution was studied as a function of time, temperature, nature of the solvent, the presence of chlorine ions in the solution, and electrode polarization. Aluminum dissolution was monitored through hydrogen liberation chromatographically measured with a coulometric sensor made from solid electrolyte. Three solutions were compared: distilled water, a solution of 20% ethanol and 80% water, and ethyl alcohol. A-99 aluminum was used in the tests. The anode was polarized with a model 173 potentiostat made by the PAR company and the potential measured using a special tri-electrode cell. During the initial stages of corrosion, aluminum dissolution was accompanied by hydrogen liberation, the kinetics of which were strongly dependent on potential, temperature, the type of solution and the presence of chlorine ions. Corrosive action was highest in water, followed by the water-ethanol solution and the ethyl alcohol. Dissolution commenced with compound oxygen-hydrogen depolarization through electrical and electrochemical mechanisms. During the initial stage of dissolution, the relative share of corrosion proceeding with oxygen depolarization grew from 0 to 78.5% throughout the series of solutions. The relative share of chemical corrosion was smallest in the ethyl alcohol and greatest in the water. References 6: 5 Russian, 1 Western.

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CSO: 1842/154

UDC 541.141

THE EFFECT OF THE CATION COMPOSITION OF HYDROXYL MELTS ON THE CORROSION RATE

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 1, Jan-Feb 86
(manuscript received 29 Jan 85, after revision 26 Apr 85) pp 131-133

[Article by D. A. Tkalenko, A. D. Kozhemyako, V. D. Prisyazhnyy and
N. A. Chmilenko, General and Inorganic Chemistry Institute, UkrSSR Academy
of Sciences]

[Abstract] The cation composition of a hydroxide melt was examined as one of the factors affecting corrosion resistance. In order to determine the possible influence of O^{2-} ions on corrosion, specific quantities of NaOH and LiOH were introduced into KOH melts. The corrosion rate of St3 steel at 500° was determined by weight. The specimens were immersed in the melt for 30 minutes. The corrosion rate was highest in pure KOH and declined when either NaOH or especially LiOH were added. The corrosion rate was closely tied to the concentration of O^{2-} -ions. These data were consistent with mathematical models of the corrosion process. References 7: 5 Russian, 2 Western.

13050/12955
CSO: 1842/154

UDC 620.193.2:536.248.2:669.14

THE COMPATABILITY OF LOW-CARBON STEEL WITH ACETONE, METHANOL AND FREON-113
WHEN USED IN HEAT PIPE

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 1, Jan-Feb 86
(manuscript received 05 Nov 84) pp 134-135

[Article by E. I. Braynin, V. A. Kolotiy and A. I. Polyakova, All-Union
Scientific-Research, Planning-Design and Technological Institute of Blast-
Resistant Electrical Mining Equipment, Donetsk]

[Abstract] Tests were done on pipe blanks made of 10 steel to determine how temperature and surface preparation affected the metal's compatibility with acetone, methanol, and freon-113. The internal surface of the pipe was scratch-brushed to high luster. The blanks were then flattened out into an oval (8-mm small axis of external diameter), and one end flattened together and argon-arc welded. Half of the blanks were then oxidized in a muffle furnace at 350°. The pipes were then filled with acetone, methanol, or freon, the other end sealed, and the coolant boiled. The drop in temperature between the ends of the pipe was measured to determine thermal exchange. The evaporative part was heated to 100° and the condenser part was cooled by the ambient air. The temperature was measured with chromel-copel thermocouples. The drop in temperature for all specimens was about 20°. The drop in temperature grew over time for the acetone and remained the same for the other coolants. Oxidation of the internal surfaces somewhat improved the transfer of heat with acetone and freon-113. References 5: all Russian.

13050/12955
CSO: 1842/154

EFFECT OF NITRIDING OF STAINLESS STEELS ON THEIR CORROSION RESISTANCE

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 2, Mar-Apr 86
(manuscript received 5 Mar 85) pp 196-211

[Article by V. Cihal, V. M. Knyazheva, J. Pitter, S. G. Babich and S. D. Bogolyubovskiy, State Scientific Research Institute of Protection of Materials imeni G. V. Akimov, Prague (CSSR), Scientific Research Physical Chemistry Institute imeni L. Ya. Karpov, Moscow (USSR), Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin, Moscow (USSR)]

[Abstract] Intergranular corrosion of stainless steels and the effect of nitriding on their corrosion resistance are analyzed on the basis of a study covering two groups of such steels: 1) low-carbon steels Cr18Ni10 and Cr18Ni13Mo3 with 0.02-0.03% C and 0-0.3% N₂; 2) ultralow-carbon steels Cr20Ni20 (0.004-0.006% C, 0.055-0.5% N₂) and Cr24Ni20 (0.005% C, 0.58% N₂). The low-carbon steels were tested upon delivery and after additional austenitization at 1050°C for 30 min with subsequent quenching in water. Some specimens were also sensitized by the standard process (heating at 650°C for 1 h + air cooling) or by a special process (heating within the range of critical temperatures for various durations of time). They were tested for corrosion, before and after nitriding, in an aqueous solution of CuSO₄ + temperature temperatures for various durations of time). They were tested for corrosion, before and after nitriding, in an aqueous solution of CuSO₄⁺ H₂SO₄⁺ Cu boiling for 24 h and in an aqueous 65% HNO₃ solution boiling for 48 h periods 3-5 times. The results were determined on the basis of mechanical 90° bending tests, metallographic examination, and phase structural analysis under an electron microscope. Specimens of the ultralow-carbon steels were quenched from 1200°C in water after 0.5 h and sensitized at 550°C and 800°C for different durations of time, this heat treatment being followed by hot rolling and then cold rolling to a 1 mm thickness. Their electrochemical and corrosion behavior, before and after nitriding, was evaluated on the basis of anodic potentiodynamic measurements in an aqueous solution of 1 n. HClO₄⁺ 0.3 n. NaCl at 20°C. Various heat treatments were applied after nitriding, the effects of which as well as those of nitriding on the corrosion resistance having then also been evaluated on the basis of mechanical 90° bending tests. Since intergranular corrosion of low-carbon stainless steels is caused principally by precipitation of M₂₃C and M₆C carbides, nitriding has practically no effect on the corrosion resistance of these steels. In ultralow-carbon stainless steels with negligible carbide formation the

principal cause of intergranular corrosion is precipitation of chromium nitride Cr_2N as excess phase. Its electrochemical behavior was studied in a separate experiment, revealing a dependence of its corrosion rate on its potential. Its nitrogen sublattice was found to be chemically active and easily reducible to the NH_4^+ ion. The effect of Cr_2N on the corrosion resistance of these steels is therefore dual. It is favorable in terms of increasing the pH of the aggressive medium at the steel surface and thus facilitating self-passivation. The effect of the Cr_2N excess phase is unfavorable because of its selective etching, most intensely by strongly oxidizing media. References 20: 12 Russian, 1 Czechoslovak, 3 East German, 4 Western.

2415/12955

CSO: 1842/189

UDC 21.357.1.035.221.2:669.231+669.295

DISSOLUTION OF PLATINUM-COATED TITANIUM ELECTRODES DURING ELECTROLYSIS WITH
ALTERNATING CURRENT

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 2, Mar-Apr 86
(manuscript received 29 Nov 84) pp 216-220

[Article by Ye. K. Spasskaya, V. I. Tkachenko, L. M. Yakimenko, V. R.
Kalinachenko, I. V. Modestova and S. D. Khodkevich]

[Abstract] Corrosion of platinum-coated titanium electrodes during a.c. electrolysis was studied, for the purpose of determining the mechanism of their fast dissolution. Tests were performed in an aqueous solution of K_2CO_3 (250 g/l, pH= 10-11) at a temperature of 25-30°C. A titanium plate with a surface area of 2 cm^2 was placed at the center of a tank with that electrolyte passing at a rate of 200 ml/h. A platinum cylinder with a total surface area of 15 cm^2 served as auxiliary electrode. Platinum was deposited on titanium by d.c. electrolysis with an aminonitrite electrolyte. Dissolution of the platinum coating during a.c. electrolysis at a frequency of 50 Hz was measured by weighing and with a β -thickness gage, while the current density was increased up to 1.5 A/cm^2 . The corrosion rate under such conditions of alternate d.c. and a.c. polarization was found to increase steeply as the current density increased from 0.1 to 0.5 A/cm^2 and then remain constant as the current density increased further. These results indicate that a.c. electrolysis can be a useful method of accelerated corrosion testing for platinum-coated titanium electrodes in production of $NaClO_4$. The high corrosion rate of a platinum coating during a.c. polarization in solutions of K_2CO_3 or other carbonates is evidently attributable to formation of an intermetallic compound, platinum + alkali metal or alkaline earth metal) during the cathodic half-cycle and its breakup during the anodic half-cycle.

References 10: 6 Russian, 4 Western.

2415/12955
CSO: 1842/189

UDC 620.199

INSTRUMENT TRANSDUCER FOR INDUSTRIAL CONTINUOUS MONITORING OF CORROSION RATE

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 2, Mar-Apr 86
(manuscript received 5 Feb 85) pp 225-231

[Article by M. Ya. Orishchenko, V. S. Novitskiy and V. S. Kuzub, State Scientific Research and Planning Institute for Methanol (Gosniimetalolproyekt)]

[Abstract] A transducer for continuous monitoring of the corrosion rate by the extrapolation method has been developed, its operation being based on the theory that within the 0-40 Hz frequency range the inductive component of charge transfer impedance is negligible and the charge transfer conductance can be found by linear extrapolation of the frequency characteristic of the conductance of the electrolyte-electrode interface to zero frequency. The principle was experimentally verified on an iron electrode corroding in solutions of H_2SO_4 with or without H_2O_2 and propargyl alcohol, the measured frequency characteristic of its impedance agreeing closely with the predicted one. An experimental transducer was built accordingly, with a two-electrode probe built into the monitored equipment. This probe transmits an admittance-to-voltage converter with an oscillator on the admittance side and an adjustable resistor for compensating the electrolyte resistance on the voltage side. The converter output signal proceeds to two synchronous rectifiers controlled by oscillator output signals. Each rectifier extracts another of the two harmonics in the input signal, whichever coincides in both magnitude and phase with the corresponding control signal. Each harmonic component is thus converted into a chopped d.c. signal so that the average rectifier output signals correspond to the conductance measured at the respective frequencies. The output signals from both rectifiers pass through a scaling and smoothing resolver-amplifier which linearly extrapolates both signals to zero frequency, and from here through a voltage-to-current converter. The transducer hardware includes series 544UD2A, K140UD6/8, K124KT1 microcircuit chips, S2-14/23 resistors, and K74-1 capacitors. The transducer has been calibrated and checked for accuracy against a KSP-4 potentiometer on St3 carbon steel in deaerated 0.1 n. H₂SO₄ solution with or without propargyl alcohol. It is suitable for the $5 \cdot 10^{-5}$ - $5 \cdot 10^{-2}$ S range of conductance and the $1 \cdot 10^{-6}$ - $1 \cdot 10^{-3}$ A range of corrosion current, with resistance compensation over the 0-1 kohm range and with a main conversion error not exceeding 1.5%. The transducer produces output signals of 0-5 mA d.c. and 0-100 mV d.c. It weight no more than 6 kg and can be used for industrial automatic corrosion monitoring as well as laboratory corrosion tests. References 6: all Western.

2415/12955
CSO: 1842/189

UDC 620.193.4

PITTING CORROSION OF 07Cr13AMn20 and 08Cr22Ni6Ti STEELS IN CHLORIDE MEDIA

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 2, Mar-Apr 86
(manuscript received 26 Oct 84, after completion 17 Dec 84) pp 237-240

[Article by S. A. Glazkova, G. S. Bukanova, T. N. Karasyuk and V. A. Moroz,
All-Union Scientific Research and Design Institute of Chemical Machinery-
Building]

[Abstract] The new 07Cr13AMn20 austenitic steel without nickel was tested for pitting corrosion in chloride solutions, for a comparison with 08Cr22Ni6Ti and 12Cr18Ni10Ti steels. The minimum (critical) pitting corrosion potential was measured by the galvanostatic method ($0.1A/m^2$) without pretreatment of the cathode; the pitting nascent potential and the repassivation potential were measured by the potentiodynamic method (1.2 V/h) of anodic polarization. The minimum pitting corrosion potential and the general corrosion potential were measured in aqueous NaCl solutions over the 0.1-5 n. NaCl concentration range at 20°C and in a 0.1 n. NaCl solution over the 20-95°C temperature range with the pH varied over the 1-14 range. Measurements were also made in 6% FeCl₃ solution at 20°C as well as in 42% MgCl₂ solution at 150°C, 35% MgCl₂ solution at 120°C, 40% CaCl₂ solution (causing also crevice corrosion), and in a typical industrial saline solution (KCl+ NaCl, 350 g/l) at 70°C and at 105°C. The resistance of 07Cr13AMn20 steel to pitting corrosion was under all these conditions lower than that of 08Cr22Ni6Ti and 12Cr18Ni10Ti steels. Its resistance to pitting corrosion will be adequate in highly dilute chloride solutions (up to 100 mg/l) at temperatures up to 40°C, its high resistance to crevice corrosion making this new steel preferable for some applications. Two perforated buckets, one made of this steel alone and one made of this steel with 10Cr17Ni13Mo2Ti steel, installed in the halurgical line of the Beloruskaliy Production Association corroded by pitting 3-4 times slower (2 mm/yr), in the absence of crevice corrosion, than did buckets made of 12Cr18Ni10Ti steel. References 10: all Russian.

2415/12955
CSO: 1842/189

UDC 539.434.620.194

DEPENDENCE OF LIFE OF NOTCHED TEST SPECIMENS UNDER FLUCTUATING TENSION ON
COMPOSITION OF AMBIENT MEDIUM

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 2, Mar-Apr 86
(manuscript received 25 Feb 85, after completion 15 Jul 85) pp 247-248

[Article by V. M. Petrik, Chernigov State Pedagogical Institute]

[Abstract] Specimens of 10CrNi4MoDV steel quenched from 860°C and tempered at 580°C into a sorbite structure, cylinders with a circumferential groove, were life tested under fluctuating tension on a short 10 cycles base in four increasingly aggressive media: air, water, aqueous 3% NaCl solution and 0.5 n. NaCl+0.01 n. HCl solution. The electrochemical effect during the initial testing period was found to be stronger in a more aggressive medium but to last longer in a less aggressive medium. The adsorption effect during the final testing period was found not to be so much different in the various media. The combination of both effects influences the fatigue resistance most, after some number of cycles (testing time) which depends on the medium and corresponds to transition from the steep initial range to the flat final range of the fatigue curve. The maximum stress at that point was found to be 568 MPa in air, 657 MPa in water, 698 MPa in aqueous 3% NaCl solution, 741 MPa in 0.5 n. NaCl+0.01 n. HCl solution. References 4: all Russian.

2415/12955
CSO: 1842/189

UDC 620.193.27

EFFECT OF CARBONATE-CALCIUM EQUILIBRIUM ON CORROSION BEHAVIOR OF St3 STEEL
IN SEA WATER

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 2, Mar-Apr 86
(manuscript received 21 Jan 85, after completion 5 May 85) pp 249-252

[Article by B. B. Chernov, Physical Chemistry Institute and T. B. Pustovskikh,
Far Eastern Corrosion Station, USSR Academy of Sciences]

[Abstract] The ion content of sea water, on which the corrosion rate of plain carbon steels depends, and the effect of Ca^{2+} - HCO_3^- equilibrium on that corrosion rate was studied in the Patrokl Bay near Vladivostok containing water saturated with atmospheric oxygen and in laboratory model solutions of 3% NaCl with additions of CaCl_2 , NaHCO_3 , MgCl_2 . Flat specimens of St3 carbon steel, with a surface area of $40 \times 70 \text{ mm}^2$ were moved around a circle at a velocity of 0.4 m/s. An x-ray phase analysis of the corrosion products in water with NaCl and Ca^{2+} ions only revealed $\gamma\text{-FeO}[\text{OH}]$ (lepidocrocite) and CaCO_3 (vaterite). Addition of Ca^{2+} or HCO_3^- ions separately did not alter the corrosion rate, but addition of one with the concentration of the other corresponding to its concentration in natural sea water inhibited corrosion. Addition of Mg^{2+} ions alone inhibited corrosion appreciably. A theoretical analysis on the basis of applicable corrosion models and ionic reactions confirms that presence of the Ca^{2+} - HCO_3^- system and Mg^{2+} ions reduces the aggressiveness of sea water to a level far below that of an aqueous 3% NaCl solution. References 10: 4 Russian, 1 East German, 5 Western (2 in Russian translation).

2415/12955
CSO: 1842/189

UDC 620.193.5

ELLIPSOMETRIC ANALYSIS OF FILM BUILDUP ON SILVER IN HCl VAPOR

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 2, Mar-Apr 86
(manuscript received 30 Apr 85) pp 252-255

[Article by M. N. Churayeva, Z. M. Zorin and V. P. Persiantseva, Physical Chemistry Institute, USSR Academy of Sciences]

[Abstract] Corrosion of silver in HCl vapor is analyzed on the basis of ellipsometric measurements and optical models interpreting them. Measurements were made with a 119XUY Gaertner ellipsometer at two wavelengths of light impinging at an incidence angle of 55°: $\lambda_1 = 585$ nm and $\lambda_2 = 522$ nm. Test specimens were produced by vacuum deposition of 99.99% Ag on glass after the latter had been flame polished. The approximately 0.5 μm thick films were optically opaque and smooth, their interferometric roughness not exceeding 5 nm. They were placed in a soft hermetic cell with windows looking into the ellipsometer tubes, the cell having been scrubbed with dry nitrogen prior to measurements. An optical model is needed for interpretation of ellipsometer readings, and two such models are available: buildup of a homogeneous AgCl film on a smooth metal surface and buildup of a heterogeneous surface layer with inclusions of aggregate metal on a microrough surface. An optimum description of the physicochemical process, including determination of the optical constants according to the Maxwell-Garnett relation, has been obtained by comparing the results of model calculations with ellipsograms and experimental data. The best fit was obtained with the model of a double-layer film, a homogeneous outer AgCl layer on top of a heterogeneous inner layer, with the Ag concentration decreasing according to the inverse-square law as the distance from the surface increases. While the inner layer continues to build up, the thickness of the outer layer remains constant after reaching its maximum within a few days. References 11: 7 Russian, 4 Western.

2415/12955
CSO: 1842/189

UDC 620.193.5

DEPENDENCE OF HIGH-TEMPERATURE OXIDATION OF METALS IN TITANIUM SUBGROUP ON
PARTIAL OXYGEN PRESSURE

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 2, Mar-Apr 86
(manuscript received 1 Oct 84, after completion 27 Mar 85) pp 256-258

[Article by A. G. Rakoch, G. A. Kravetskiy, B. K. Opara, M. N. Fokin and
V. I. Iremashvili, Moscow Steel and Alloys Institute]

[Abstract] High-temperature oxidation of metals in the titanium subgroup is analyzed theoretically in terms of its dependence on the partial oxygen pressure. It is demonstrated that the mechanism of oxidation is different within different ranges of that pressure, measurements having revealed four successive ranges within which the mean oxidation rate respectively increases, decreases, again increases, and finally either decreases or remains constant. Within the lowest range only a solid solution of oxygen in the metal forms. Above the critical pressure, which depends on the temperature and on the metal, a dioxide film forms on the metal surface and the metal becomes passivated. Oxides with oxygen deficiency form within the fourth range. Oxides with oxygen deficiency and oxides with excess oxygen form within the fourth range. The partial oxygen pressure at which passivation of the metal again occurs is higher at higher temperatures, 150 Pa at 1570 K and 6 kPa at 1870 K for zirconium, passivation within this range being associated with inhibition of anodic reactions. References 8: 7 Russian, 1 Western.

2415/12955
CSO: 1842/189

UDC 620.195

INCREASING CORROSION RESISTANCE OF MA21 Mg-Li ALLOY BY LASER SURFACE TREATMENT

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 2, Mar-Apr 86
(manuscript received 28 Sep 83, after completion 6 Aug 85) pp 262-264

[Article by R. Kh. Kalimullin and A. T. Berdnikov, Ural Automobile Plant]

[Abstract] The corrosion behavior of the MA21 Mg-Li alloy (8% Li, 5% Al, 4% Cd, 1% Zn, 0.4% Mn) after laser surface treatment was studied, the purpose being to confirm the feasibility of increasing its corrosion resistance by this method. Specimens hot-pressed into cylinders 25 mm in diameter were coated with a light-absorbing film by oxidation in a $70\text{ K}_2\text{CrO}_4 + \text{MgSO}_4 + 40\text{ (NH}_4\text{)}_2\text{SO}_4$ g/l solution. They were then irradiated with an LGN-702 continuous-wave CO_2 -laser at a power level of 800 W and with the beam 5 mm in diameter scanning the surface at a rate of 1.6 cm/s. After irradiation and removal of some molten material, some specimens were phosphate coated with a $40\text{ ZnPO}_4 + 30\text{ ZnNO}_3 + 1.5\text{ NaF}$ g/l solution and some were oxidized as before. All were then tested for corrosion in aqueous 0.001% NaCl and 3% NaCl solutions at 25°C. The volume of hydrogen evolving in 24 h per 1 cm^2 of alloy surface was found to have been reduced from original 3.5 cm^3 to 0.3 cm^3 after irradiation and then to 0.1 cm^3 after phosphate coating or to 0.01 cm^3 after oxidation. Electrochemical measurements have confirmed a shift of the corrosion potential into the passivation range and a much lower dissolution current within that range as a result of laser surface treatment. Examination under an ISM-35 CF scanning electron microscope, x-ray structural analysis in a DRON-1.5 diffractometer with a CrK_α -radiation source and a "Kvantimet-720" quantimeter, and x-ray spectral analysis in a "Cameca" microanalyzer revealed a more uniform distribution of alloying elements and absence of large grains in the phosphate films after laser treatment. Accordingly, laser surface treatment does produce a fine-grain structure in the MA21 alloy so that the corrosion resistance increases and phosphate or oxide coatings on it become more stable. References 4: all Russian.

2415/12955
CSO: 1842/189

UDC 621.316.938

COMBINED DEPENDENCE OF PROTECTIVE CHARACTERISTICS OF CHROMIUM COATINGS ON
COMPOSITION OF ELECTROLYTE AND FORM OF POLARIZING CURRENT

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 2, Mar-Apr 86
(manuscript received 15 Jun 84, after completion 5 Apr 85) pp 270-271

[Article by Ye. N. Kutygin, V. T. Fomichev and A. M. Ozerov, Volgograd
Construction Engineering Institute]

[Abstract] The protective characteristics of chromium coatings on structural steel were measured with an R-5035 corrosimeter in aqueous 10% NaCl solution for an evaluation of two methods of improving them. Addition of aluminum ions to the electrolyte, an aqueous solution of dimethylformamide with Cr(III) salts, was found to reduce internal stresses. Conversion from direct current to pulse current, with a repetition rate of 50 Hz and a 0.5 duty factor, was found to reduce internal stresses even more effectively. A combination of both measures stabilized internal stresses at a still lower level so as to make them almost independent of current density and coating thickness. As a result, the performance of protective chromium coatings could be improved by a factor of 1.5-10. References 9: all Russian.

2415/12955
CSO: 1842/189

11

UDC 621.793:620.193:546.74:541.138.2:541.135

PROTECTIVE CHARACTERISTICS OF GALVANIC COATINGS OF Ni-BASE COMPOSITE MATERIALS

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 2, Mar-Apr 86
(manuscript received 15 Feb 85) pp 271-273

[Article by T. Ye. Tsupak, V. N. Dakhov, N. N. Valeyev and I. N. Andreyev,
Moscow Chemical Technology Institute imeni D. I. Mendeleyev]

[Abstract] Galvanic nickel coatings with SiC and Cr₂O₃ inclusions, which not only increase the microhardness and the strength but also reduce the cost of the coating deposition process, were tested for corrosion protection of steel in aqueous 0.1 n. NaCl solution. Coatings were produced from four different electrolytes containing 187 Ni(CH₃COO)₂·4H₂O + 30 NiCl₂·6H₂O g/l with HCl up to pH= 5, at 50°C. To electrolyte 1 had been added 80 g/l analytically pure Cr₂O₃. To electrolytes 2,3,4 had been added 20 g/l fine SiC powder and surfactants: also added were 1.5 g/l DL-asparagin (electrolyte 2), 0.2 g/l polyethylene glycol (electrolyte 3) and 0.5 g/l γ-aminopropyl triethoxysilane (electrolyte 4). Corrosion of cylindrical cathodes made of St3 carbon steel in 0.1 n. NaCl was measured immediately after immersion and 24 h later, using an AgCl reference electrode and an R-3003 voltage comparator. Cathodic polarization curves were plotted with potentiostats at a rate of 1 mV/s. The data, fitted into second-degree polynomials by the method of least squares according to the ST3RADI program on an ODRA-1204 computer, indicate that most protective are coatings from electrolyte 1 and least protective are coatings from electrolyte 3. The protective characteristics of 20-30 μm thick coatings from electrolyte 1 are almost independent of the deposition current density. The protective characteristics of coatings from electrolyte 3 worsen with increasing deposition current density and more so as their thickness increases. The corrosion current density through the coatings from electrolytes 2 and 4 is almost independent of the deposition current density and their protective characteristics improve consistently with increasing thickness. References 4: all Russian.

2415/12955
CSO: 1842/189

UDC 620.197.6

ORGANOSILICON ANTICORROSION COMPOUNDS FOR POWDER-METAL PRODUCTS

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 2, Mar-Apr 86
(manuscript received 21 May 85) pp 276-279

[Article by Ya. M. Zolotovitskiy, I. S. Litmanovich and V. N. Zagrivnyy,
Special Design Bureau for Analytical Instruments Making]

[Abstract] A new compound is proposed for corrosion protection of powder-metal products which not only makes the surface water-repellent but also seals up pores. It is based on polyethyl hydrosiloxane and products of tetraethoxysilane hydrolysis. Grade 136-41 polyethyl hydrosiloxane as water-repellent fluid was mixed with benzene as solvent and with ETS-32 ethyl silicate as solvent, the latter containing 50-65% tetraethoxysilane and 30-34% disperse SiO_2 sol. The viscosity and the flash temperature of each system have been determined over the entire 0-100% 136-41 range. Specimens of PZh4M1 iron were impregnated with 10% or 40% 136-41 in benzene and with 5% or 40% 136-41 in ETS-32, then coated with a 15 μm thick cadmium film, and so tested in a tropical climate chamber: first in air with $95\pm 3\%$ humidity at $55\pm 2^\circ\text{C}$ temperature for 16 h, then in air with 100% humidity at 50°C temperature for 8 h. The readings of electrochemical parameters indicate a much lower corrosion current with than without impregnation. Only impregnation with ETS-32 as solvent produces a positive shift of the corrosion potential, however, possibly because of chemisorption with formation of Si-O-metal bonds or because of better pore sealing. The dependence of the corrosion potential on the repellent concentration indicates an interaction of Si-H bonds and OH- groups in H_2SiO_3 . Addition of 1% urotropine will stabilize the impregnant within 1-1.5 month, with a polymerization temperature of 90-100°C.

References 8: 7 Russian, 1 Western.

2415/12955

CSO: 1842/189

UDC 620.193

INHIBITING CORROSION OF FRESH METAL SURFACE

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 2, Mar-Apr 86
(manuscript received 5 May 85, after completion 25 Jun 85) pp 281-282

[Article by L. N. Petrov, A. Yu. Kalinkov, V. A. Borisov and A. N. Magdenko,
Odessa Technological Institute of the Food Industry]

[Abstract] Four corrosion inhibitors were tested on a fresh surface of 12CrNi steel acting as cathode in a "fresh surface - old surface" galvanic couple during stress cracking, immersed in aqueous 3% NaCl solutions either neutral (pH= 7.1) or acidified (pH= 6.1-1.8). Halogen derivatives of quinoline such as N-(4-methyl quinoline) pyridine iodide (0.37 kg/m³) were found to stimulate rather than inhibit corrosion in insufficiently acidic media. Most effective in neutral media and even more so in acidic media was found to be K₂Cr₂O₇ (2.9 kg/m³), probably owing to a polarity "reversal" of the galvanic couple. Of the other two inhibitors, Na₂WO₄ (3.3 kg/m³) is effective in neutral media but appreciably stimulates corrosion in acidic ones and Na₂C₄O₆H₄ (0.5 kg/m³) + NiCl₂ (0.5 kg/m³) slightly inhibits corrosion in neutral media. References 7: all Russian.

2415/12955
CSO: 1842/189

UDC 620.198

ELECTROCHEMICAL STUDY OF PROTECTIVE CHARACTERISTICS OF MODIFIED EPOXY COATINGS

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 2, Mar-Apr 86
(manuscript received 14 Feb 85, after completion 17 May 85) pp 299-301

[Article by Yu. V. Yemelyanov, L. S. Kanevskiy, M. Yu. Khenkina and A. V. Mosolov, All-Union Scientific Research Institute for the Protection of Metals from Corrosion]

[Abstract] Protective coatings of ED-20 epoxy resin modified by addition of 7.7-25 wt.% SKN 26 1A butadiene-nitrile caoutchouc (molecular mass approximately 3500, 3% COOH- groups), with polyethylene polyamine as hardener and toluene as solvent, were deposited on 1.5 mm thick and 50x100 mm² large plates of St3 carbon steel for corrosion tests in aqueous 3% NaCl solution at 20+2°C temperature. Measurements were made with a 3-electrode press-on cell including an AgCl₂ reference electrode. A comparative evaluation of modified coatings on the basis of three principal performance indicators, namely corrosion potential, polarizability, and magnitude of cathode/anode currents, indicates that epoxy resin with 20 wt.% SNK 26 1A caoutchouc has the best protective characteristics. A higher caoutchouc content evidently weakens the adhesion between coating and steel. The life of unmodified epoxy resin is altogether short, high stresses causing it to crack after a few days already. References 5: all Russian.

2415/12955
CSO: 1842/189

FERROUS METALS

UDC 620.17:620.18:669.14.018.44

THE EFFECT OF NITROGEN AND HEAT TREATMENT ON THE STRUCTURE AND PROPERTIES
OF 31Kh19N9MVBTI HEAT-RESISTANT STEEL

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 2,
Feb 86 pp 34-37

[Article by N. P. Aleksandrova, Casting Problems Institute, USSR Academy
of Sciences]

[Abstract] The influence of the temperature of austenizing with subsequent water quenching and the aging temperature on the mechanical properties of steel alloyed with nitrogen versus non-nitrogen alloyed steel was investigated. The optimal temperature range for austenization was 1200 to 1220°C. Steels alloyed with nitrogen (0.07 to 0.13%) showed a 10 to 15% increase in tensile strength, yield point, and strength up to 600°C and with stress between 250 and 300 MPa. Plasticity and impact strength was somewhat lower in the non-alloyed steel. The same percentage of nitrogen alloy also prevents the formation of the σ -phase out of the ferrite. The greatest plasticity at working temperature was obtained after aging at 650°C. Maximum impact strength was achieved between 600° and 650 ° aging temperature. The strengthening action of nitrogen was manifested at austenizing temperatures higher than 1150°C.

References 4: all Russian.

13050/12955
CSO: 1842/147

UDC 621.74.002.6:669.13

BEHAVIOR OF PHOSPHIDE EUTECTIC OF CAST IRON AT OPERATING TEMPERATURE OF BRAKE SHOES

Moscow LITEYNAYE PROIZVODSTVO in Russian No 3, Mar 86 pp 5-6

[Article by B. L. Levintov, candidate of technical sciences, T. V. Larin, doctor of technical sciences, B. M. Astashkevich, candidate of technical sciences and L. A. Bashayeva, engineer]

[Abstract] Using cast iron alloyed with phosphorus for brake shoes in railroad rolling stock will lengthen their life, their frictional and wear characteristics being then largely dependent on the properties of the phosphide eutectic. According to the constitution diagram of the ternary system Fe-C-P, the phosphide eutectic contains 2.4% C + 6.9% P and forms at a temperature within the 945-953°C range. For a study of its behavior, a phosphide eutectic was produced synthetically by alloying Armco iron with iron phosphide and carbon soot. The product was found to contain 2.16% C + 6.3% P according to chemical analysis. Its phase composition, according to structural analysis by x-ray diffractometry, was found to be $Fe_3P + Fe$ C + $\alpha<Fe$. Processes occurring in this material were studied over the 20-1360°C temperature range, so as to cover the operating temperature of brake shoes, using the thermoanalytical method with a Paulik-Erday derivatograph in an argon atmosphere. Subsequent metallographic and microstructural examination indicates that the phosphide eutectic plays a dominant role in formation of surface layers. These surface layers were also found to contain phosphates $Fe_3(PO_4)_2$ and $FePO_4$, which contribute to the excellent mechanical characteristics of such layers: mobility, elasticity, and resistance to seizure.

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CSO: 1842/194

UDC 621.74.043-984

CONTACT BETWEEN CASTING AND MOLD UNDER LOW PRESSURE

Moscow LITEYNAYE PROIZVODSTVO in Russian No 3, Mar 86 pp 23-24

[Article by G. P. Borisov, doctor of technical sciences and D. M. Belenkiy, candidate of technical sciences]

[Abstract] The duration of contact between casting and mold prior to formation of a gap during the solidification process was measured by two methods for the purpose of determining its dependence on the gage pressure in the chill. Experiments were performed with slabs of AL2 and AK21M22.5N2.5 aluminum alloys cast by the continuous process in a chill with 30 mm thick walls. One measurement was made by the temperature method, with a chromel-alumel thermocouple reading the temperature of the surface layer and connected to a KSP-4 potentiometer. This measurement yielded not only the instant of time at which a gap between casting and mold had begun to form but also data on the kinetics of solidification and on the dynamics of heat transfer from casting to mold. Another measurement was made by the pressure method, with a U-tube water manometer installed through a chill wall and indicating the appearance of the first discontinuity in the contact between casting and mold. After the chill had been filled at a constant rate of 3 cm/s, the gage pressure was held constant by automatic control till the end of the solidification process. An analysis of the data reveals a linear relation between duration of contact and gage pressure, namely $t_c = t_c^0 + c p_g$ (t_c^0 - duration of contact under zero gage pressure, c - proportionality factor characterizing the mechanical strength of the solid crust). From this relation can be determined the total solidification time after pouring of the melt has begun. This relation also indicates the advantages of casting under low pressure. References 3: 2 Russian, 1 Western.

2415/12955
CSO: 1842/194

UDC 621.74Δ621.3-523.8:669.13

AUTOMATIC INSPECTION AND QUALITY CONTROL SYSTEM FOR HIGH-STRENGTH CAST IRON

Moscow LITEYNNOYE PROIZVODSTVO in Russian No 3, Mar 86 pp 29-31

[Article by A. N. Snigir, candidate of technical sciences, G. B. Petrov, engineer, A. Yu. Konov, engineer and P. V. Matveyev, engineer]

[Abstract] An automatic system of inspecting and controlling the process of metal structurization during casting has been developed at the Metallurgy Institute imeni A. A. Baykov (USSR Academy of Sciences) and installed at the Lenin Plant (Gorkiy) to ensure consistent production of high-strength cast iron with globular graphite inclusion. The system is based on thermal analysis and is designed for operation with a standard computer. It monitors the phase composition and structure during solidification by comparing the readings of process parameters with a preconstructed mathematical model of crystallization and eutectoidal transformation according to the Fe-Si-C constitution diagram. In case of deviations it determines the optimum corrections of melt composition, melting process parameters, and out-of-furnace treatment, an important factor being addition of 1.5-2.3% Mg, Ca hardener or FeSi75 secondary modifier. The mathematical model of crystallization is based on qualitative and quantitative analysis of internal heat generation with the aid of cooling curves characterizing the physicochemical process of cast iron structurization. The automatic system uses these curves to construct the model and then the control algorithm, to program the latter, to analyze the results, and finally to control the object. Its hardware consists of a melt sampler-analyzer and a computer complex. The latter includes a processor, two direct-access memories, a data storage, a device for parallel data transfer from thermocouple through digital voltmeter, a device for sequential data transfer to a symbolic display or to a graphic display, and a printer. This automatic system, with a DVK-2M minicomputer, has been integrated into the "Plavka" automatic control system for the entire founding operation. Its operation at the Lenin Plant has saved 5 rubles per ton of castings by completely eliminating rejects with laminar graphite inclusion, by economization of scarce Mg hardener, and by reduction of the labor cost of melt spot inspection and quality control. Participating in the project were engineers A. S. Averyushkin, A. V. Dudik, A. A. Levin, and S. N. Rashkeyev. References 4: 3 Russian, 1 Western.

2415/12955

CSO: 1842/194

UDC 66.046.51:546.17

CONSTANTS CHARACTERIZING MASS TRANSFER AND SURFACE REACTION DURING GASSING
AND DEGASSING OF METAL MELT

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in
Russian No 3, Mar 86 (manuscript received 4 Jan 85) pp 26-30

[Article by D. A. Romanovich and A. G. Svyazhin, Moscow Steel and Alloys
Institute]

[Abstract] The rates of nitrogen absorption and desorption by pure iron (0.0001-0.0272 wt.% [N], 0.002-0.14 wt.% [O], 0.005-0.008 wt.% [S], 0.01-0.12 wt.% [C]) were measured, with the iron melt in an electromagnetic field suspended in a stream of spectrally pure gases (N_2 + 1 wt.% H_2 , Ar+ 1 wt.% H_2 , Ar) under a pressure of 10^5 Pa. A mass of 2.3-2.8 g was suspended in a stream flowing at a rate of $700 \text{ cm}^3/\text{s}$. The frequency of the electric current was 65 kHz. Concentration measurements were made inside an open quartz tube. Only two successive stages of each process are considered in the analysis, mass transfer in the metal and surface reaction, the third stage of mass transfer in the gas being disregarded. The approximating model consists of both first-order and second-order differential equations. Statistical processing of the data and minimization of a function of several variables by Euler's numerical method have yielded $K_1 = 0.0045-0.0085 \text{ cm/s}$ for the coefficient of mass transfer and $K_2 = 1.45-1.80 \text{ cm}^4/(\text{g}\cdot\text{s})$ for the rate constant of surface reaction. References 4: all Russian.

2415/12955
CSO: 1842/197

UDC 669.141.24

DEVELOPMENT OF EFFICIENT TECHNOLOGY FOR PRODUCTION OF CAST Cr-Ni-Mo STEELS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in
Russian No 3, Mar 86 (manuscript received 14 Mar 85) pp 39-42

[Article by T. A. Kozlova, V. S. Krasilnikov and V. F. Kravchenko]

[Abstract] A better technology of producing cast Cr-Ni-Mo steels has been developed, microalloying with boron having been found not only to allow lowering the nickel content so as to avoid transcrystallization without lowering the hardenability but also to eliminate the need for lengthy and costly homogenizing at temperatures above 1150°C for 40 h. In order to realize the full effect of boron, it is necessary to deoxidize the steel and otherwise protect boron from oxidation or nitridation. This is achieved by adding boron in the form of 20% ferroboron together with aluminum. Although titanium and zirconium form more stable nitrides and thus would be more effective, they also react with boron forming borides and cause embrittlement. A comparative evaluation of specimens cast from experimental and conventional ladles, then tested mechanically for strength and toughness, indicates that addition of 0.006-0.015% B allows decreasing the nickel content by 30% without degrading the quality of the steel.

2415/12955
CSO: 1842/197

UDC 621.793.6:621.822

DIFFUSION CHROMIZING OF BALL-BEARING STEEL

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 3, Mar 86 (manuscript received 23 May 85) pp 110-113

[Article by G. N. Dubinin and G. L. Oganesyan, Moscow Institute of Civil Aviation Engineers]

[Abstract] Chromizing of two ball-bearing steels, ShKh15 and 95Kh18, by the diffusion process, for the purpose of improving their wear and corrosion characteristics was studied. Specimens of these steels were impregnated with the standard 50% Cr+ 47% Al₂O₃+ 3% NH₄Cl mixture at temperatures of 850-1100°C for 1-9 h. Diffusion chromizing was found to produce a surface layer consisting of two carbides, (Cr,Fe)₂₃C₆ and (Cr,Fe)₇C₃, its total thickness increasing with higher treatment temperature and with longer treatment time. Both Cr and Fe concentration profiles across the diffusion layer were measured in a Cameca MS46 analyzer under an accelerating voltage of 20 kV, with the beam moving at a speed of 1/30 cycle/min and with a current of 40 nA flowing through the specimen. Wear resistance was measured in a UV-1 friction machine under a pressure load of 118 kPa and at a sliding velocity of 0.6 m/s, at room temperature in air and with TsiATIM-201 lubricant applied only once. Corrosion resistance in a 4% aqueous NaCl solution was measured over a period of 10 days. Both wear resistance and corrosion resistance were found to be increased by diffusion chromizing. The slight buildup of dimensions, 10-12 µm of a 6 mm diameter, without increase or even with slight decrease of roughness indicates that this process can be used for restoration of worn aircraft bearings. References 3: all Russian.

2415/12955
CSO: 1842/197

NONFERROUS METALS AND ALLOYS; BRAZES AND SOLDERS

UDC 669.21'3:548.313.3:538.212

THE MAGNETORESISTIVITY OF Cu₃Au ALLOYS WITH DIFFERENT DEGREES OF ATOMIC ORDER

Moscow FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 61, No 1, Jan 86
(manuscript received 27 May 85) pp 74-78

[Article by N. I. Kurov, Yu. N. Tsiovkin, N. V. Volkenshteyn and M. Glinskiy,
Metal Physics Institute, Ural Scientific Center, USSR Academy of Sciences]

[Abstract] The effect of a magnetic field on the electroresistivity of Cu Au was studied in order to isolate a possible component of magnetoresistivity in Pt₃Fe. Electroresistivity was measured by the four-point method using direct current and wire specimens 0.2 mm in diameter. Magnetoresistivity was determined at temperatures of 4.2, 79, and 300K in strong magnetic fields up to 15 teslas generated in a Bitterov solenoid. The lengthwise and transverse magnetoresistivities of the alloys were positive and proportional to H^{3/2} in large fields. At higher temperatures, the values for the changes in the magnetoresistivities dropped. These values also dropped as the degree of longrange atomic order was reduced. The behavior of the magnetoresistivities was caused by the electrons of conductivity twisting in the magnetic field as a result of the anisotropy of their Fermi surface (Lorentz effect) and the relaxation time. This behavior was consistent with the Kohler rule. The nature of the magnetoresistance of the Cu Au alloy and Pt₃Fe was identical for both substances. References 13: 7 Russian, 6 Western.

13050/12955
CSO/1842/150

UDC 669.24'295:548.76/.73.295

THE EFFECT OF REVERSE SHAPE MEMORY DURING VARIABLE-SIGN PLASTIC WORKING

Moscow FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 61, No 1, Jan 86
(manuscript received 12 Dec 84, in final version 05 Feb 85) pp 79-85

[Article by S. L. Kuzmin, V. A. Likhachev and Ch. Kh. Toshpulatov, Leningrad State University imeni A. A. Zhdanov]

[Abstract] Specimens of titanium nickelide were subjected to various forms of complex plastic working. Deformation was induced in the specimens by cooling them under constant stress as they passed from the austenitic to the martensitic states, i.e., deformation resulted from the transformation plasticity effect (EPP). The specimens were relieved of stress and twisted at -196°C. They were then heated in a state free of stress, during which time the shape memory effect (EPF) was manifested. The magnitude of deformation and the recovery kinetics of the EPF were found to be dependent on the correlation of cumulative deformations resulting from the EPP and subsequent plastic working. "Reverse" EPF was manifested when residual cumulative deformation was less than 3%. This property is associated with the extent of plastic working applied to the specimens. Further investigation of the EPF and reverse EPF (REPF) was done. The specimens were subjected to variable-sign twisting at -196° and 25°C and then heated in a stress-free state. The shape memory effects were noticeably affected by the way stress was applied, the extent of deformation, and the temperature at which plastic working was done. It was shown that, by varying stress and the nature of plastic working, the metal could be endowed with normal and "reverse" shape recovery. This was attributed to the inherent properties of TiNi. References 13: 12 Russian, 1 Western.

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CSO: 1842/150

UDC 621.039.531:537.311.3:538.6

THE GALVANOMAGNETIC EFFECT IN IRRADIATED NICKEL

Moscow FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 61, No 1, Jan 86
(manuscript received 18 Feb 85) pp 94-97

[Article by V. F. Zelenskiy, I. M. Neklyudov, Yu. T. Petrusenko, E. A. Reznichenko and A. N. Sleptsov, Kharkov Physical Technical Institute, USSR Academy of Sciences]

[Abstract] The electroresistivity field dependence and the magnetoresistance of pure nickel were studied. The specimens were made of 99.992% pure nickel about 100 mcm thick. They were recrystallization annealed in a vacuum for 1 hour at 1073K. Specific residual resistivity was measured by standard potentiometry. The galvanomagnetic properties were studied at 4.2K in a lengthwise magnetic field generated by a superconducting solenoid. The specimens were irradiated on an LU-40 accelerator by electrons with energy equal to 30 MeV in a helium cryostat at 4.2K and 523+10K. Isochronous annealing within 4.2--500K was done after the low-temperature irradiation. Low-temperature irradiation resulted in the formation of isolated point radiation defects, which led to an increase in residual electroresistivity. Irradiation at the higher temperature annealed these defects, significantly reducing the depth of the low without changing the para-process part of the electroresistivity field dependence. During isochronous annealing, the magnetoresistance value fell until it was characteristic of the nickel in its original state. It was shown that magnetoresistance can be used to evaluate radiation damage in ferromagnetic metals. References 11: 5 Russian, 6 Western.

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CSO: 1842/150

UDC 669.017.3:669.245

THE KINETICS OF THE ISOTHERMAL DECAY OF THE SUPER-SATURATED SOLID SOLUTION
OF KhN62BMKTYu ALLOY

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 2,
Feb 86 pp 37-39

[Article by V. P. Zryumov and A. Ya. Shinyayev]

[Abstract] The kinetics of the precipitation and coagulation of γ' - phase particles was studied. Specimens of KhN62BMKTYu (0.04% C, 13.8% Cr, 2.5% Ti 2.5% Al, 2.6% Nb, 5.0% Mo, 9.9% Co) with a supersaturated solid solution structure alloy 10 mm in diameter and 60 mm long were cut from bars extruded on a horizontal press. Some of the specimens were held for 8 hours at a homogenous-state temperature of 1120° and then placed in a furnace heated to 900, 950, 1000, and 1050°C and held for 0.15, 1, 4, 8, 16, 64, and 216 hours at each temperature, followed by accelerated cooling in a 15% aqueous solution of NaCl. The rest of the specimens were rapidly cooled from the homogenous-state temperature and then reheated to 650, 750, 800, and 850°C, held for the same time intervals as the first group, and cooled in water. Electrochemical phase analysis was used to determine the number of strengthening phases. An EMMA-2 electron microscope was used to determine particle size. The maximum rate of solid solution decay occurred within the temperature range of 900 to 1000°C. The maximum amount of strengthening γ' -phase was precipitated at aging temperatures between 750 and 800°C, when time was equal to or greater than 8 hours. Increases in time and temperature resulted in faster particle size growth in the γ' -phase. In all cases, the particles were spherical. At temperatures between 750 and 800°C, the alloy's hardness properties increased as holding time was increased to 64 hours. Temperatures above 850°C and holding times longer than 8 hours led to deterioration in hardness. References 4: all Russian.

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CSO: 1842/147

UDC 669.297:669.245

THE EFFECT OF HAFNIUM ON THE STRUCTURE AND PROPERTIES OF NICKEL-BASED DEFORMABLE ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 2, Feb 86 pp 39-43

[Article by L. N. Zimina and N. N. Burova, Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin]

[Abstract] The effect of alloying various nickel-based alloys with hafnium was studied. The hafnium was added to the molten metal 2 to 3 minutes before teeming. After being heated to 1150°C, ingots of KhN67MVTYu, KhN57MTBYu, and KhN70BYu were forged into rods 22 mm in diameter. KhN65KMVYuB ingots up to 25 kg were formed on a horizontal press into rods 35 mm in diameter. The specimens were then subjected to various heat-treatment procedures. X-ray crystallography showed that hafnium displaced aluminum, niobium, and titanium atoms in the corresponding nitrides and comminuted the non-metallic inclusions. Excess hafnium caused the formation of an intermetallide phase with up to 28% hafnium, primary $Ni_7(Hf,Ti)_2$ - and $Ni_3(Nb,Hf)$ -type phases, and secondary laminar phases $Ni_3(Ti,Hf)$ and $Ni_3(Nb,Hf)$. Hafnium had a powerful carbide-forming effect resulting in a simultaneous increase in MC carbides and decrease in M_6C carbides. Some of the hafnium became alloyed with the solid solution and became part of the strengthening Y'-phase as it was precipitated during aging. From 0.2 to 0.5% Hf comminuted the grain and inhibited its growth between 1100 and 1200°C. Hafnium increased hardness at 20°C without appreciably affecting plasticity. Between 700 and 800°C, hafnium alloying had a positive effect on tensile strength, elongation, reduction, and yield strength. Hafnium also improved the alloys' weldability. References 6: 3 Russian, 3 Western.

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CSO: 1842/147

UDC 621.77.016

GRAIN ORIENTATION OF PLATINUM COATING

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 3, Mar 86 (manuscript received 11 Jun 85) pp 98-100

[Article by B. L. Linetskiy, V. G. Roshchupkin, N. V. Chirikov and T. S. Roshchupkina, Moscow Steel and Alloys Institute]

[Abstract] The grain orientation of platinum coating on titanium was studied, such a coating having been produced by hot rolling onto a titanium strip in a single pass under vacuum and subsequent cold rolling of the bimetal strip to 90-97% total reduction. The titanium strip with a 5-10 μ m thick platinum coating was annealed first at 450°C and then at 700°C. The grain structure was examined in a DRON-2 diffractometer with a CoK_{α} -radiation source and a GP-2 photographic attachment. The results indicate how the preferred grain orientation of an extra-thin platinum coating is influenced by the substrate metal and the heat treatment. In this case the preferred orientation (001)[110] after cold rolling is retained after annealing at 450°C for 30 min. Annealing at 700°C intensifies this orientation, but also intensifies the (112)[111] orientation characteristic of metals with an f.c.c. crystal lattice as well as (110)[111] and (113)[110] orientations. The titanium substrate evidently plays an insignificant role here. References 3: all Russian.

2415/12955
CSO: 1842/197

DOMESTIC BOF REFRactories PASS TEST AGAINST FOREIGN COMPETITION

Leningrad LENINGRADSKAYA PRAVDA in Russian 6 May 86 p 2

[Article by S. Samoylis: "In the Dispute with Competitors"]

[Text] Recently, the All-Union Refractories Scientific Research Institute received visitors from the Cherepovets Metallurgical Combine in order to decide the question of building a refractories production shop. All-in-all, it was a usual meeting between customers and development people; there was a business-like discussion of the schedules for the preparation of technical documentation and the construction work details were made more precise. The unusual item was the fate of a development that the metallurgists were preparing to put into practice.

How did it all start? The institute had received a phone call from Moscow, from the USSR Ministry of Ferrous Metallurgy: "Do you know that our refractories "burn" when we operate the BOFs with combination blowing?" -- asked the deputy minister. "We need your help."

The problem was serious. A number of combines had started to employ so-called combination blowing for melting of steel by the progressive BOF method. This practice offers considerable advantages over previous methods.

It reduces the molten pig iron consumption, makes it possible to use more scrap, and improves the steel quality. All would be fine if it were not for one "but". The melt motion is faster than before, and it wears the BOF bottom refractories more rapidly.

How should one approach this problem? You see, what was needed was not merely a new, highly refractory monolithic block, but a complex design with millimeter-size openings for blowing of an inert gas.

To find the optimum solution was the job for the specialists of the BOF refractories laboratory -- the only laboratory in the country that works on the development of BOF refractories. Candidate of technical sciences V. G. Borisov, who has been directing the laboratory for about 20 years, has succeeded in assembling a strong team of like-minded persons that has proven more than once its ability to deal with big problems. They immediately started the search for "new" refractories. Although this subject was not

included in the institute's work program until November, they began the study immediately after they received the order.

"The first step was to study carefully the technical literature", relates V. G. Borisov. "However, we were quickly convinced that the only hope were our own, fundamentally new solutions. Ideas concerning the type and composition of refractories and the technology for the production of multi-channel blocks arose almost every day. Some solutions were rejected immediately on the basis of discussions. Other solutions failed to pass laboratory tests."

Of course, when the research is conducted by the entire collective, it is difficult to name the author of the final solution. This is why the technology of production of unfired refractories developed in the laboratory should be regarded as a collective success. Preliminary calculations showed that refractories produced according to this technology should withstand more than 500 heats. At least the first block, which was made at the laboratory, showed high refractory properties.

As a rule, there is no problem with introduction when an entire ministry, rather than just one or two enterprises, is interested in the development. Already after the first experimental lot had been tested, the institute received a request from Novokuznetsk: "We are introducing the combination-blow melting practice. Please send your refractories." Several lots of blocks were shipped by air to the West Siberian Metallurgical Combine.

Another kind of blocks, twice as long as the previous ones, was soon produced in Borvichi with the collaboration of the specialists from the institute's experimental shop. Scientists from V. G. Borisov's laboratory traveled to Novokuznetsk to test them.

"The results were simply discouraging" -- admitted Vladimir Grigoryevich. "Instead of the 500 planned heats, we obtained barely more than 280. Of course, this did not please us nor the metallurgists. All the benefits of the combination blowing practice nearly vanish when the bottom blocks have to be changed frequently. Yes, we had to listen to many criticisms in those days."

What had gone wrong? Had an error sneaked into the calculations? Had there been a fault in the manufacture of the experimental blocks? After a thorough analysis of the experimental results the scientists confirmed that the refractories should withstand 500 heats.

"Then why don't they?" -- demanded the metallurgists. "Where are the 500 heats?"

The tests continued, but the results remained negative. As before, the refractories wore out after 250-280 heats. And then the scientists proposed to study how the process of rising the blocks is maintained. "There is no sense in blaming our technology" -- said the metallurgists. "Foreign refractories have a longer life under the same conditions. It is because of their quality."

The refractories specialists recommended their own, optimum in their opinion, mode of using the refractories. This included an altered slag mode for the converter and a different rate of blowing gas through the blocks. The number of heats increased immediately. Does this mean that not only refractories are responsible? Then an idea occurred to make comparative tests in the combine's BOF and to invite leading foreign firms to participate in the tests.

The decision was upheld by the USSR Ministry of Ferrous Metallurgy. The institute workers had confidence in the competitiveness of their development and in the improved melting practice, but they did not waste the time remaining before the tests. They persistently improved the design of the blocks and increased their refractoriness. The test they faced was serious. They had to compete with well-known refractories firms from Austria, German Federal Republic, and Japan. Experimental lots of their products were shipped to Novokuznetsk. Representatives of one of the Japanese firms that supplied their refractories for this unique competition also arrived in Novokuznetsk. After studying the operating mode, they declared: "Our refractories will withstand at least 1000 heats."

"There were many predictions" -- recollect the institute workers. "We were worried, of course, about one question: how will our refractories fare?"

A set of refractories of an Austrian firm, which, incidentally, exports a large part of its production to various countries, withstood 325 heats. The next set, a West German one, 293 heats.

"The Japanese products were of a higher quality" -- V. G. Borisov joins the conversation. But their test gave somewhat unexpected results. The refractories of the first firm wore out after 496 heats. The blocks of the second Japanese firm withstood only 413 heats. The development of the Leningrad scientists was the last to be tested.

We made a measurement after 300 heats, and after determining the rate of wear of the refractories we stopped worrying" -- says candidate of technical sciences Ye. Ya. Shapiro, who was in Novokuznetsk during those stressful days. "It became clear to everyone: we are equal to the competition."

The heats followed one another, four hundred, five hundred... As later they admitted at the combine, nobody had expected 531 heats.

Today, with all this behind us, we can safely sum up the results. The most important result is that the domestic development proved to be at the level of the world's better products, not in words and calculations but in fact. If earlier a question of buying the license for the technology of production of a similar block has been raised at the Ministry of Ferrous Metallurgy, this question is no longer relevant. The scientists have succeeded in "refining" the existing refractories production process at the Magnesit Combine and in avoiding the spending of millions for replacement of equipment.

The path from an idea to industrial production was covered in a very short time -- in three years. Today the Magnesit Combine already produces

large-size refractory blocks for all metallurgical enterprises that are being changed over to combination-blowing modes of BOF smelting. Very recently, the laboratory workers brought from Cherepovets the records of the tests of the new refractories. The records did not contain any questions or remarks.

12973/12955
CSO: 1842/209

NONMETALLIC MATERIALS

UDC 549.211:548.5

GROWTH AND MORPHOLOGY OF SYNTHETIC DIAMOND PLATE CRYSTALS

Kiev SVERKHTVERDYYE MATERIALY in Russian No 1, Jan-Feb 86
(manuscript received 12 Mar 85) pp 6-13

[Article by A. I. Chepurov, Yu. N. Palyanov, A. F. Khokhryakov and Yu. M. Borzdov, Geology and Geophysics Institute, Siberian Department, USSR Academy of Sciences, Novosibirsk]

[Abstract] Results are presented from long-term experiments on the production of elongated and compacted diamond crystals. The morphology of the crystals and fractures causing anomalous shape distortions are discussed. A multiple die sectional sphere high-pressure apparatus was used in the studies. The method of creating the pressure was described in an earlier work. All diamonds were sorted into six main groups: individual single crystals, crystals with microtwinning, spinel twins, spinel twins with lamellae, semisynthetic and cyclical twins. The values of l , h , d (length, width and thickness of crystal) were measured for all diamonds, then the l/d and h/d ratios were determined, characterizing the shapes of the crystals, after which summary shape characteristics were calculated. Use of this analysis to study shape distortions in diamonds significantly increases the information content and reliability of experimental results. It was found that two factors are significant in the production of elongated and thickened crystals: the presence of twinning boundaries and favorable orientation of diamonds relative to the feed stream. With a relatively large number of crystallization centers, diamond growth occurs in accordance with the law of geometric selection. Low growth rates, between 0.4 and 12 $\mu\text{m}/\text{min}$, over long crystallization times yield diamonds with small numbers of inclusions. References 12: 9 Russian, 3 Western.

6508/12955
CSO: 1842/185

UDC 666.233:[542.943+539.219.1:546.74/.65]

OXIDATION RESISTANCE OF DIAMONDS OBTAINED IN THE PRESENCE OF INTERMETALLIDES
OF Ni AND RARE EARTH ELEMENTS

Kiev SVERKHTVERDYYE MATERIALY in Russian No 1, Jan-Feb 86
(manuscript received 1 Feb 85) pp 13-16

[Article by O. Yu. Zhdankina, I. I. Kulakova, I. V. Nikolskaya, A. A. Putyatin,
P. A. Ramazanova and A. P. Rudenko, Moscow State University]

[Abstract] A study is presented of the influence of the nature and composition of intermetallic compounds used in the synthesis of diamonds on their oxidation resistance. Powders in the 100/50 μm fraction were obtained at R-T parameters corresponding to the area of thermodynamic stability of diamond in a 7 mm diameter toroidal chamber in 30 seconds. Oxidation resistance experiments were performed in a quartz catalytic installation with a built-in platinum reactor to prevent contact between the powders and the quartz. Differences in oxidation resistance of diamond powders are explained by the catalytic influence of the impurities in the diamond on its oxidation. The results allow recommendation of intermetallic compounds of the GdNi and ErNi composition to produce the most thermally stable diamond powders. References 7: all Russian.

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UDC 669.018.45:661.55

OXIDATION OF HEXANITE-R POLYCRYSTALS WITH VARIOUS PHASE COMPOSITIONS

Kiev SVERKHTVERDYYE MATERIALY in Russian No 1, Jan-Feb 86
(manuscript received 11 Sep 84) pp 16-18

[Article by A. V. Bochko, V. A. Lavrenko, V. L. Primachuk and T. G. Protsenko,
Institute of Materials Science Problems, Ukrainian Academy of Sciences; Kiev
Polytechnical Institute]

[Abstract] A study is made of high-temperature oxidation of hexanite-R in air with varying contents of sphalerite, wurzite and graphite-like boron nitride. Experiments were performed on a differential thermal analysis installation using a type OD-103 derivatograph in the temperature interval from room temperature to 1500°C with programmed heating at 15 degrees per minute. The phase composition of the specimens was determined by x-ray studies in filtered copper radiation by the method of reflection from a section. It was found that polycrystals containing large quantities of the sphalerite phase were most resistant to high temperature oxidation. Partial transformation of wurzite to sphalerite occurs during synthesis of hexanite-R, accompanied by a process of collective recrystallization and formation of particles with less clearly expressed polycrystalline structure, decreasing the surface energy of the particles and increasing their high temperature oxidation resistance. References 3: all Russian.

6508/12955
CSO: 1842/185

UDC 621.912:661.65:661.55.66.046

STUDY OF INTERACTION OF CUBIC BORON NITRIDE WITH OXYGEN AND NITROGEN

Kiev SVERKHTVERDYYE MATERIALY in Russian No 1, Jan-Feb 86
(manuscript received 30 Jul 84) pp 19-23

[Article by A. P. Garshin and V. Ye. Shvayko-Shvaykovskiy, Leningrad Poly-
technical Institute; Silicate Chemistry Institute, USSR Academy of Sciences]

[Abstract] A study is presented of the behavior of cubic boron nitride when heated at various partial pressures of oxygen and nitrogen. Micropowders of commercial cubic boron nitride type LM with rather high specific surface, about $0.5 \text{ m}^2/\text{g}$, were used in the experiments. The surface of the BN was initially cleansed of adsorbed substances by heating it in a high vacuum. Interaction of the CBN with oxygen and nitrogen were studied on a precision thermo-mass-spectrometric installation with a sensitivity of $2\mu\text{g}$ per scale division allowing both recording of the temperature at which oxidation begins and evaluation of the dynamics of the process. The sorption capacity of the powder was found to be about 100 mmol/m^2 , indicating high adsorption activity of the surface of the material. The probable mechanism of oxidation has two stages: molecules of oxygen are sorbed on active centers of the surface and defects in the boron nitride, after which the process of oxidation actually occurs. Oxidation begins at 950 K with a partial oxygen pressure of $2.1 \cdot 10^4 \text{ Pa}$. The specimens studied had nonstoichiometric surface composition: the B:N ratio is 1.3:1. Interaction of β -BN with N_2 depends on the partial pressure of nitrogen in the system. References 16: 3 Russian, 3 Western (1 in Russian translation).

6508/12955
CSO: 1842/185

UDC 666.1.004.547.473

USING CAPROLACTAM WASTES IN THE PRODUCTION OF GLASSWARE

Moscow STEKLO I KERAMIKA in Russian No 2, Feb 86 pp 7-8

[Article by N. I. Minko, S. S. Sabitov and Yu. L. Belousov, candidates of technical sciences, M. V. Chabotko and V. I. Onishchuk, engineers, Belgorod Construction Materials Technological Institute imeni I. A. Grishmanov, Neman Glass Plant, Kuybyshevazot Production Association]

[Abstract] The use of soda dross from the Shchokino Azot Production Association as an alkaline raw material in the production of glass was studied. Plate glass was made in a silite furnace at a maximum temperature of 1420 to 1430°C, cast in metal molds, and annealed in a muffle furnace. The oxides were introduced through conventional raw materials. Fluorine, the opacifier, was introduced using sodium hexafluosilicate. No differences in the way this glass and conventionally made glass behaved during the glass-making process were detected. It was milk-white and satisfactorily opaque. Glass for making glassware was processed in an electric silite furnace at a maximum temperature of 1410°C. One hour was required for complete fusion and clarity. This glass was made with 70.7% SiO_2 introduced through Novoselkovskoye sand, 10.8% Na_2O introduced through soda dross, 0.85% Na_2O introduced through sodium nitrate, and 5.4% K_2O , 6.5% CaO , 3% BaO , 1.6% Al_2O_3 , and 1% B_2O_3 introduced through carbonates and oxides. In comparison with glass made with conventional sodas, the soda-dross glass fused much more quickly, was light blue in color, and had 83.4% transparency. Industrial tests were made on soda-dross glass. The soda dross was first crushed and sifted. The charge was fused in a direct-heat, two-crucible gas furnace in a slightly oxidized atmosphere at a maximum temperature of 1420°C for 16 hours and churned with compressed air. The glass yielded products of satisfactory quality. Soda dross was considered an acceptable alternative to conventional sodas for making certain types of glass. References 3: 2 Russian, 1 Western.

13050/12955
CSO: 1842/153

UDC 666.151:666.155

HEATING SHEET GLASS FOR SUBSEQUENT INTENSIVE HARDENING

Moscow STEKLO I KERAMIKA in Russian No 2, Feb 86 pp 14-16

[Article by V. I. Potapov, engineer, All-Union Scientific Research Institute of Industrial and Structural Glass (VNII tekhnstroysteklo)]

[Abstract] The dynamics of heating glass were studied to determine the optimal cycle for heating glass prior to hardening. Sheet glass of varying thicknesses was heated at a source temperature ranging from 650° to 900°C with a derived emissive power of $C^* = 0.7$. The source temperature substantially affected the length of time required to heat the glass to hardening temperature as well as the gradient and final drop in temperature between the surface and the central layer of the glass. Acceleration of the heating cycle is constrained by the drop in temperature throughout the thickness and by the product's susceptibility to deformation. The best results were obtained when accelerated heating was followed by holding the product at a source temperature of 650°, which is very close to hardening temperature. This caused the final temperature drop to virtually disappear at the moment the glass reached hardening temperature. These data were obtained by using a Nairi-3-1 computer to employ R. Z. Fridkin's and O. V. Mazurin's algorithm and to calculate the source radiant energy distribution according to Plank's law. The optimal arrangement of the heaters was determined by analyzing the energy characteristics of the irradiation distribution over the surface of the glass and calculating the angle coefficients for infrared radiation transport. References 5: all Russian.

13050/12955

CSO: 1842/153

UDC 666.1.053.562:666.251

ION-EXCHANGE COLORATION OF THERMALLY POLISHED GLASS

Moscow STEKLO I KERAMIKA in Russian No 2, Feb 86 pp 16-17

[Article by N. A. Vereshchagina, engineer, A. M. Butayev, candidate of chemical sciences and S. P. Boroday, candidate of physico-mathematical sciences]

[Abstract] Thermally polished glass from the Borskij glass works were colored with silver ions, and industrial light filters were made using the ion-exchange method. The ion exchange was done in a melt consisting of sodium and silver nitrates. AgNO_3 molecular content varied from 1% to 5%, ion-exchange temperature ranged from 350° to 450°C, and the ion-exchange process lasted from 0.17 to 6 hours. Subsequent open-air heat treating was done at temperatures ranging from 470° to 620°C for 0.25 to 4 hours. Spectral curves were taken on an SF-14 spectrophotometer using an attachment that can measure spectral characteristics within a temperature range of 25° to 300°C. The spectra were used to calculate the chromaticity coordinates for the source. Color tone and purity were determined from a color chart. A wide range of yellow to brown tones were obtained. The spectral characteristics of the light filters could be varied considerably by regulating the ion-exchange and heat treatment processes. Supplemental heat treatment of the filters up to 470°C decreased their integral light transmission; at 620°C, this property was just as likely to increase as to decrease. Supplemental heat treatment was found to be an effective way to economize on AgNO_3 melt and to refine the spectral characteristics of the filters. Coloring one side of the glass or pickling it in a solution of HF increased the versatility of the ion-exchange coloration technique. Light filters colored in this manner were highly heat-resistant. Ion-exchange coloration was found to be a cost-effective way to make light filters with pre-determined spectral characteristics and highly heat-resistant optical properties. References 5: 3 Russian, 2 Western.

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CSO: 1842/153

UDC 666.192

INCREASING THE HEAT RESISTANCE OF QUARTZ SEMICONDUCTOR GLASSWARE

Moscow STEKLO I KERAMIKA in Russian No 2, Feb. 86 p 18

[Article by G. I. Zhuravlev, doctor of technical sciences, V. G. Leyv and N. G. Serkova, engineers and V. S. Khotimchenko, candidate of chemical sciences, Leningrad Technological Institute imeni Lensoveta, State Scientific Research Institute of Ceramics and Glass (gosNIIKS)]

[Abstract] The toughness, temperature coefficient of linear expansion (TKLR), and the initial deformation temperature of various compounds were studied to determine their suitability as heat-resistant coatings on quartz glassware. The compounds selected were from the following systems: SiO_2 -- HfO_2 , SiO_2 -- ZrO_2 , Al_2O_3 -- TiO_2 -- SiO_2 and ZrO_2 -- SiO_2 -- P_2O_5 . The compounds chosen had to have a crystalline phase concentration of not less than 50% in the final product. Brazilian SiO_2 , its corresponding chemically pure oxides, and chemically pure orthophosphoric acid were used to synthesize the compounds. The phosphate systems were obtained under oxidation in a SNOL-type furnace at 900° to 1100°C. The others were synthesized at 1950°C under weakly reducing conditions in an SShVL-type furnace with molybdenum heating elements. The zirconium-phosphate coatings yielded the best results. This compound had the highest effective toughness (12.7 to 12.9), an initial deformation temperature of 1500°C, and a TKLR of 27--29 (measured on a DKV-1 dilatometer). The zirconium-phosphate coating was also tested for thermal stability by subjecting 60x60x3 mm quartz glass specimens with 0.1 to 0.2 mm-thick coatings to 15-18 thermocycles ranging from 20° to 1000°C. No cracking or sloughing of the coating was detected. This coating could also be applied at a relatively low temperature. References 2: both Russian.

13050/12955
CSO: 1842/153

UDC 666.762

HIGH-ALUMINA MILLING COMPONENTS

Moscow STEKLO I KERAMIKA in Russian No 2, Feb 86 p 23

[Article by T. G. Kuzmenko, I. V. Kaganova and A. I. Panashenko, engineers, Ukrainian Scientific Research Institute of the Porcelain Industry (UkrNIIFP)]

[Abstract] The durability of milling components made from alumina and additives of boric acid, barium carbonate, chalk, talc, dolomite, zinc oxide, flourspar, calcium phosphate, and various chemical by-products was studied. The optimal composition of materials was 75% to 85% aluminna and up to 15% dolomite and talc. Refractory clay and bentonite were used as plasticizers. Sulphite-alcohol waste was used to speed up the grinding and to strengthen the semi-finished product. The raw material was finely ground in a ball mill, dessicated on a filter-press, and double vacuum compacted. The semi-finished product was dried and fired at a temperature of 1430° to 1450°C. Milling components made in this manner had improved physical and mechanical properties.

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THE EFFECT OF COBALT OXIDE ON THE STRUCTURE AND PHASE COMPOSITION OF MATERIALS CONTAINING ZIRCONIUM

Moscow STEKLO I KERAMIKA in Russian No 2, Feb 86 p 24

[Article by O. S. Vladimirova, engineer, A. I. Gruzdev, candidate of physico-mathematical sciences, Z. L. Koposova, engineer and L. A. Lyutsareva, candidate of the technical sciences, VNIIT]

[Abstract] The effect of cobalt oxide on the structure and phase composition of $0.91 \text{ ZrO}_2 + 0.09 \text{ Y}_2\text{O}_3$ specimens was studied. The concentration of the cobalt oxide additive varied from 10% to 90%. The specimens were made by compacting and sintering powdered components at 1350°C . X-ray crystallography revealed a reduction in the lattice parameter of the sintered specimens. X-ray phase analysis on a DRON-5 diffractometer showed that the specimens had multiple phases. Optical and electron microscopy revealed that the specimens had a relatively large-grained microstructure and inclusions of the CoO and Co_3O_4 phases. Specimens with 50% and more cobalt oxide contained evenly distributed individual grains of the solid solution phase of $\text{ZrO}_2 - \text{Y}_2\text{O}_3 - \text{CoO}$ in a matrix consisting of CoO and Co_2O_4 phases. An REM (scanning electron microscope)-200 was used to determine that porosity size and distribution were consistent with previous data. An increase in the concentration of cobalt oxide was accompanied by tendencies towards smaller average grain size and an increase in apparent density. During the synthesis of the specimens, the original components partially dissolved in one another and a three-phase matrix-type heterogenous system was formed with three types of groups. These data show that adding cobalt oxide to zirconium-containing materials affects their structure and phase composition. References 3: 1 Russian, 2 Western (in Russian translation).

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ANOMALOUS CHANGES OF CHARGE CARRIER MOBILITY IN GaAs BOMBARDED WITH FAST ELECTRONS AFTER QUENCHING

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 3, Mar 86
(manuscript received 20 Jun 84) pp 357-359

[Article by N. F. Kurilovich, F. P. Korshunov and T. A. Prokhorenko, Solid State and Semiconductor Physics Institute, BSSR Academy of Sciences]

[Abstract] Effects of electron bombardment on quenched crystals of intrinsic GaAs was made, the changes in the charge carrier mobility being of interest. Specimens of single crystals with initial $5 \cdot 10^{15} \text{ cm}^{-3}$ concentration and $5000 \text{ cm}^2/(\text{V.s})$ mobility of majority carriers were oriented by the x-ray method in the (111)-plane within $\pm 30'$, polished, rinsed in water distillate, etched with a $3\text{HNO}_3 + 1\text{HF} + 2\text{H}_2\text{O}$ mixture at 330 K for 40-50 s, heated to 1270 K and, after 45-60 min, quenched in water. The heat treatment was followed by bombardment with 4 MeV electrons in doses up to $2 \cdot 10^{15} \text{ electrons/cm}^2$ in an ELU-4 linear accelerator at room temperature. Their electrical resistance and the Hall effect were then measured accurately within $\pm 5\%$. The dependence of the Hall mobility on the bombardment dose at 300 K and the temperature dependence of the Hall mobility were measured, for comparison, also in specimens which had not been bombarded after quenching and in specimens which had been bombarded without prior quenching. The results indicate that, after quenching, the Hall mobility first anomalously increases and only then normally decreases with increasing bombardment dose. References 2: 1 Russian, 1 Western (in Russian translation).

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UDC 548.522

CHARACTERISTICS OF DOPING EPITAXIAL GaAs LAYERS WITH TIN FROM GASEOUS PHASE
IN $\text{Ga-AsCl}_3\text{-H}_2$ SYSTEM

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 3, Mar 86
(manuscript received 20 Jun 84) pp 360-362

[Article by L. I. Dyakonov, V. N. Ivlev, N. I. Lipatova, M. G. Milvidskiy
and V. V. Nechayev, State Scientific Research and Planning Institute of Rare
Metals Industry]

[Abstract] A method of doping epitaxial GaAs layers with tin from a separate gaseous phase is proposed, together with a method of controlling the process. In an experimental feasibility study epitaxial GaAs layers were grown in a vertical reactor on a turntable. Substrates with a surface inclined by 3-5° from the [100] plane to the [110] plane were doped to a level corresponding to a charge concentration of about $2 \cdot 10^{18} \text{ cm}^{-3}$, with the source at a temperature of 1038 K and the deposition temperature varied over the 988-903 K range. Tin was placed in a separate quartz vessel and the latter was connected to the reactor through a narrow channel. AsCl_3 vapor, in amounts varied from 0 to $5 \cdot 10^{-8}$ mole/s, was added to the hydrogen stream sweeping the tin. Transport of tin to the reactor by means of such an arrangement is effected by the two reactions $2\text{AsCl}_3 + 3\text{H}_2 \rightarrow 6\text{HCl} + \text{As}_2$ and $\text{Sn}_{\text{lig}} + 2\text{HCl} \rightarrow \text{SnCl}_2 + \text{H}_2$ occurring in succession. The tin content in doped layers is indicated by the concentration of free electrons. The impurity concentration profile can be established on the basis of voltage-capacitance measurements, this profile being an indicator of the doping process characteristics as functions of the deposition temperature and the AsCl_3 rate. References 4:
3 Russian, 1 Western.

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UDC 546.681'193

STATE OF IRON IMPURITY IN GASEOUS AND SOLID PHASES DURING EPITAXIAL GROWTH OF
GaAs in $\text{Ga-AsCl}_3\text{-H}_2$ SYSTEM

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 3, Mar 86
(manuscript received 12 Jun 84) pp 363-366

[Article by M. D. Vilisova, G. M. Ikonnikova, V. A. Moskovkin, M. P. Ruzaykin,
A. I. Saprykin, V. B. Yabzhanov and M. P. Yakubanya, Tomsk State University
and Siberian Physical Technical Institute imeni V. D. Kuznetsov]

[Abstract] An experimental study of GaAs epitaxy in the $\text{Ga-AsCl}_3\text{-H}_2$ system and of doping with iron from the gaseous phase was made, pure iron filings serving as the impurity source and transported from a separate vessel to the reactor by the $\text{AsCl}_3\text{+H}_2$ stream. Doping with iron was effected in the presence of controllable shallow donors, their source being a small batch of tin placed in the gallium source and the Sn concentration in the epitaxial layers being varied over the $10^{15}\text{-}10^{17}$ atoms/cm³ range. The substrates were GaAs plates with an electrical resistivity not lower than 10^7 ohm·cm and a 2°(100) orientation. Their temperature during the epitaxial process was 1020 K, the temperatures of the gallium source and the iron source being 1100 K and 1070 K respectively. Hydrogen was passed through the growth channel at a rate of 9 l/h, through the dilution channel at a rate of 15 l/h, and through the doping channel at rates of 0.5-2 l/h. A thermodynamic analysis of the gaseous phase in chemical equilibrium has revealed the presence of FeCl_2 , this phase with a partial pressure above 0.1 Pa (at 1020 K) promoting formation of a FeAs solid phase in the doping zone. During doping the Fe concentration in the layers increased by an order of magnitude, from the initial $2\cdot10^{16}$ atoms/cm³ in layers only doped with tin to $2\cdot10^{17}$ atoms/cm³ after doping with iron, regardless of the rate of flow of $\text{AsCl}_3\text{+H}_2$ and thus producing epitaxial layers with an electrical resistivity of the order of 10^4 ohm·cm. The rate of epitaxial growth decreased fast, however, as the rate of $\text{AsCl}_3\text{+H}_2$ flow was increased. The electrophysical properties of such GaAs layers with Sn and Sn+ Fe impurities were measured, the temperature dependence of these properties revealing the activation energy of the deep Fe acceptor level or levels. A topographical examination by the x-ray method revealed precipitation of a second phase in concentrations of $800\text{-}1500$ cm⁻² in Fe-doped GaAs layers, but the composition of this phase could not be determined. References 9: 5 Russian, 4 Western.

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UDC 621.315.592

ELECTROPHYSICAL AND OPTICAL PROPERTIES OF SiAs SINGLE CRYSTALS

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(manuscript received 29 Jun 84) pp 367-377

[Article by Ya. A. Ugay, O. V. Klyuchnikova, Ye. G. Goncharov, V. N. Semenov
and A. Ye. Popov, Voronezh State University imeni Lenin Komsomol]

[Abstract] A study of SiAs single crystals was made for the purpose of determining the pressure dependence of their electrophysical properties and infrared absorption spectrum during their growth. Specimens were grown by directional crystallization from a solution-melt with the As vapor saturation pressure varied over the 0.2-1.0 MPa range. From the crystals there were cut out 0.5 mm thick $4 \times 10 \text{ mm}^2$ large plates for measurement of the electrical resistivity by the 2-probe method with the current flowing in the direction of the monoclinic b-axis, measurement of the thermal emf with the temperature gradient normal to the (201)-plane, and measurement of the infrared absorption coefficient over the 400-4000 cm^{-1} region of the spectrum, all under an increasing pressure. The results have confirmed and refined the reversal of the differential thermal emf and the steep rise of electrical resistivity within the 0.25-0.4 MPa pressure range. The infrared absorption spectrum did not change, retaining its characteristic 410, 450 and 525 cm^{-1} bands over the entire pressure range. The results indicate the conditions for existence of a thermodynamic p-n junction within the region of a homogeneous compound. References 3: all Russian.

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UDC 537.312.7+536.21+546.273.171

ELECTRICAL CONDUCTIVITY AND THERMAL CONDUCTIVITY OF β -BN

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(manuscript received 20 Jun 84) pp 418-421

[Article by V. B. Shipilo, I. P. Guseva, G. V. Leushkina, L. A. Makovetskaya and G. P. Popelnyuk, Solid State and Semiconductor Physics Institute, BSSR Academy of Sciences]

[Abstract] A study of sintered β -BN was made for the purpose of determining the effects of Se-doping and thermal annealing on its electrical conductivity and thermal conductivity. Single crystals of cubic BN were grown from powder of hexagonal BN mixed with a catalyst-solvent and with 0-0.5-1.5-2.5-3.5 wt.% Se, at a temperature of 2200 K under a pressure of 4.3 GPa. Lump specimens for metallographic and x-radiographic examination in a DRON-1 diffractometer with a $\text{CuK}\alpha$ -radiation source and a nickel filter as well as for electrical conductivity and thermal conductivity measurements were produced from such crystals 40-80 μm in diameter by sintering at high temperature and pressure within the range of thermodynamic equilibrium for cubic BN. Evaporation of selenium during these high-temperature processes lowered the Se content in small single crystals to 0-0.016-0.034-0.046-0.056 wt.% and the Se concentration in large lump specimens to $0-(2.4-6.1-10-6.8) \cdot 10^{24}$ atoms/cm³. The dislocation density was determined from the number of pits revealed by etching with an aqueous KOH solution. The Se concentration was measured by the x-ray fluorescence method, using a ^{109}Cd radioisotope with a total activity of the order of 1 MBk as excitation source and a BDRK-1 semiconductor-type detector with a multichannel analyzer. The dislocation density was found to increase monotonically with increasing Se concentration, with the microhardness fluctuating because of thermodynamic variance. The density of specimens was measured by hydrostatic weighing and found to be $3.41 \pm 0.4\%$ g/cm³, lower than the theoretical 3.48 g/cm³ density of β -BN because of microporosity and microcracks. The electrical conductivity, measured over the 300-1100 K temperature within 3% accuracy before annealing and after annealing at temperatures of 900-1000 K, was found to increase with the temperature but decrease with increasing Se concentration. Annealing was found to increase the electrical conductivity of all specimens appreciably at room temperature and negligibly at temperatures above 700 K. The thermal conductivity, measured over the 300-650 K temperature range by the relative static

method within 10% accuracy, was found to first decrease sublinearly with increasing temperature up to 400 K and then remain constant above 400 K. It was found to increase with Se concentration, unlike the thermal conductivity of other $A^{III}B^V$ compounds, and to be higher after annealing. References 11: 9 Russian, 2 Western.

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GLASSES OF As_2S_3 - Tl_2S SYSTEM

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(manuscript received 25 Jun 84) pp 477-479

[Article by M. S. Gutenev, Leningrad Polytechnic Institute imeni M. I. Kalinin]

[Abstract] In addition to the two compounds in the As_2S_3 - Tl_2S system, TlAsS_2 melting congruently at 280°C and Tl_3AsS_3 melting noncongruently at 290°C , it has been possible to crystallize the TlAs_3S_5 compound in the $(\text{AsS}_{1.5})_{1-x}$ ($\text{TlS}_{0.5}x$) system forming in a peritectic reaction at 220°C . This was achieved by stimulating crystallization with 0.03 wt.% Ni powder. The range of compounds forming glass by slow cooling is $0 \leq x \leq 0.50$ and the range of compounds forming glass by quenching is $0 \leq x \leq 0.70$, the TlAsS_2 compound ($x = 0.50$) being of special interest because of existence in it of complexes and of a chemical atomic ordering describable by $\text{TlSAsS}_2/2$ structural units. This is confirmed by the composition dependence of molar volume and molar infrared polarizability, both calculated on the basis of experimental data on the dielectric permittivity, the refractive index, and the density over the $0 \leq x \leq 0.61$ range of composition and thus sufficiently far beyond the $x = 0.50$ point. Both molar volume and molar infrared polarizability have a distinct singularity at the $x = 0.5$ point, the former a minimum and the latter an inflection. The nonlinear trend of this composition dependence of molar infrared polarizability, with maximum deviation from additivity within the $x = 0.20-0.25$ range, indicates a strong interaction of $\text{TlS}_{0.5}$ and adjacent unbound $\text{AsS}_{1.5}$ structural elements.

References 13: 11 Russian, 2 Western.

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CSO: 1842/192

UDC 666.11.01+541.12.017+548.0:535

PHASE EQUILIBRIA AND CRYSTALLIZATION OF GLASSES IN Na_2O - La_2O_3 - Y_2O_3 - P_2O_5 SYSTEM

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 3, Mar 86
(manuscript received 12 Jun 84) pp 480-484

[Article by Ye. N. Fedorova, L. K. Shmatok, I. I. Kozhina and T. R. Barabanova, State Optics Institute imeni S. I. Vavilov]

[Abstract] The phase equilibria of four pseudobinary systems cutting through the Na_2O - La_2O_3 - Y_2O_3 - P_2O_5 constitution diagram were studied: $\text{La}(\text{PO}_3)_3$ - NaPO_3 , $\text{Y}(\text{PO}_3)_3$ - NaPO_3 , $\text{La}(\text{PO}_3)_3$ - $\text{Y}(\text{PO}_3)_3$ and $\text{LaP}_5\text{O}_{14}$ - $\text{Y}\text{P}_5\text{O}_{14}$. The purpose was to determine their crystallizability and the glass formation ranges of their compositions. Melts were produced from extra-pure Na_2CO_3 , La_2O_3 , Y_2O_3 and 70% aqueous H_3PO_4 solution in a Silit furnace with quartz crucibles and mixers, at temperatures of 1000-1550°C depending on the composition, and poured onto a steel plate for subsequent annealing in a muffle furnace. Their crystallizability and liquidus temperature were determined on the basis of polythermal measurements. Their phase compositions were determined on the basis of crystal-optical and x-ray measurements. All four systems were found to form glass over their entire composition ranges, pentaphosphate glasses being least prone to crystallization. The authors thank V. V. Rusan for assistance in synthesizing the glasses and for practical suggestions.

References 13: 7 Russian, 6 Western.

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UDC 666.3:541.15

FERROELECTRIC PROPERTIES OF PZFN-CERAMICS

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 3, Mar 86
(manuscript received 12 Jun 84) pp 485-488

[Article by B. P. Blazhyevskiy, V. A. Isupov, L. V. Kozlovskiy, L. I. Mikhaylova, V. I. Moskalev and N. Ye. Semenov, Leningrad Technology Institute imeni Lensoveta]

[Abstract] A study of $PbZr_{1-x}(Fe_{0.5}Nb_{0.5})_xO_3$ ceramics was made for the purpose of determining their properties. Specimens of these solid solutions were produced from analytically pure PbO and Fe_2O_3 , pure ZrO_2 , and extra-pure Nb_2O_3 . The ingredients were fused at a temperature of 1070 K for 6 h and the product pulverized in agate mortars with ethyl alcohol. The powder was compacted into pellets 10 mm in diameter and these were sintered for 0.5-1 h at a temperature of 1370-1520 K depending on the composition. Replacement of Zr^{4+} ions by Fe^{3+} and Nb^{5+} ions facilitated sintering at a lower temperature in less time. Both fusion and sintering took place in hermetically sealed crucibles in an atmosphere of PbO vapor produced from $PbZrO_3$ pellets also placed in the crucibles. The constitution diagram of the $PbZr_{1-x}(Fe_{0.5}Nb_{0.5})_xO_3$ system, determined on the basis of x-radiographic analysis at room temperature, was found to cover four phases of solid solutions: a rhombic pseudotetragonal one ($0 \leq x \leq 0.1$); an ionically disordered rhombohedral one ($0.1 \leq x \leq 0.45$); an ionically ordered one with a Zr^{4+} -sublattice and a (Fe^{3+}, Nb^{5+}) -sublattice ($0.45 \leq x \leq 0.55$); and an ionically disordered one with the $Zr:(Fe+ Nb)$ ratio far from 1:1 ($0.55 \leq x \leq 1.00$). Dielectric permittivity and loss tangent were measured at room temperature in an alternating electric field of 6 kV/m intensity and 1 kHz frequency. The results reveal a transition from antiferromagnetic material to ferromagnetic material at the $x = 0.07$ composition boundary. Materials with $x < 0.07$ have a linear field dependence of polarization and no spontaneous polarization. Materials with $x > 0.07$ have a distinct dielectric hysteresis with saturation and a high spontaneous polarization. The dielectric permittivity ϵ_{33} , the electromechanical coupling coefficient K , and the piezoelectric modulus d_{31} as well as its dielectric sensitivity d_{31}/ϵ_{33} are all maximum when the material has a composition close to the $x = 0.55$ point on the $Pb(Fe_{0.5}Nb_{0.5})_xO_3$ side (except ϵ_{33}). The temperature of maximum dielectric permittivity (Curie point) remains almost the same over the $0 \leq x \leq 0.4$

range of compositions but drops fast beyond that range. Acoustic measurements, revealing that the velocity of ultrasound passes through a minimum (3300 m/s) in material with a composition near the $x = 0.55$ point, indicate that these PZN ceramics have piezoelectric characteristics on par with those of the best PZT ceramics such as the TSTS-19. References 6: 1 Russian, 5 Western (2 in Russian translation).

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UDC 546.824.431-31

EFFECT OF EXCESS TiO_2 ON ELECTRICAL CONDUCTIVITY OF REDUCED AND DOPED
 $BaTiO_3$ CERAMICS

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 3, Mar 86
(manuscript received 21 Dec 83) pp 519-520

[Article by N. P. Velikaya, M. A. Kvantov, G. D. Rubalskiy and V. K. Yarmarkin]

[Abstract] The effect of excess TiO_2 on the properties of $BaTiO_3$ and the mechanism of this effect have been determined through thermogravimetric and magnetochemical analysis of the reduction of $BaTiO_3$, stoichiometric and with excess TiO_2 , of $Ba_6Ti_{17}O_{40}$, and of TiO_2 . Specimens for this study were produced by mixing analytically pure $BaCO_3$ and extra-pure TiO_2 , then fusing them in air at a temperature of 1570-1670 K depending on the composition. Thermogravimetric measurements, with a sensitivity of 0.03 mg, were made during linear heating of specimens at a rate of 1000 K/h. The results of those measurements made in air indicate that stoichiometric $BaTiO_3$ does not lose mass at temperatures up to 1770 K. Addition of TiO_2 , 3 mol.% and 7 mol.%, results in a loss of mass beginning at 1470 ± 10 K by an amount proportional to the excess TiO_2 . Petrographic and x-ray analysis have revealed an attendant buildup of $Ba_6Ti_{17}O_{40}$ as second phase from zero (pure $BaTiO_3$) to 10%. Reduction of specimens with excess TiO_2 was found to occur at a rate sharply increasing at the 1585 K eutectic point of the $BaTiO_3$ - $Ba_6Ti_{17}O_{40}$ system and then decreasing to near zero, owing to a fast decrease of the open surface area during sintering. Reduction of $Ba_6Ti_{17}O_{40}$ in air could not be recorded, because of this and because of reduction beginning at a temperature near the temperature of noncongruent melting. Reduction of TiO_2 in air was found to begin at 1400 ± 10 K. During annealing in moist hydrogen with a 263 K dew point, the reduction process being activated here under a low partial oxygen pressure, reduction of stoichiometric $BaTiO_3$ was found to be noticeable and reduction of $BaTiO_3$ with excess TiO_2 was found to proceed in two stages with the first stage beginning at the same temperature as reduction of $Ba_6Ti_{17}O_{40}$. Electrical resistance measurements have confirmed the principal role of the $Ba_6Ti_{17}O_{40}$ phase in determining the semiconductor conductivity of $BaTiO_3$ ceramic during reduction annealing. Addition of 7 mol.% TiO_2 decreases the electrical resistivity from 10^{11} to 10^2 ohm \cdot m. Magnetochemical measurements have revealed that the paramagnetic component of magnetic susceptibility increases with increasing excess TiO_2 , an indication of increasing concentration of Ti^{3+} ions. References 8: 4 Russian, 4 Western.

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CSO: 1842/192

PREPARATION

UDC 669.15'74-194:621.762

TECHNOLOGY OF PRODUCING MEDIUM MANGANESE POWDER STEEL TYPE 60GZp

Yerevan PROMYSHLENNOST ARMENII in Russian No. 12, Dec 85 pp 29-31

[Article by Yu. G. Dorofeyev, Doctor of Technical Sciences and K. Ye. Ananyan, Engineer]

[Abstract] A study was undertaken to develop a technology for production of 60GZ manganese steel powder by hot stamping of sintered blanks by varying the hot stamping temperature and initial porosity of the sintered blanks. The data obtained indicate some decrease in the strength and ductility of the specimens with decreasing initial porosity. The final porosity of all specimens was virtually the same, the influence of the degree of deformation being eliminated by rather complete recrystallization resulting from the varying conditions of pore ventilation and reduction of the oxides contained in the material. Heat treatment greatly influences the structure of the material and its properties. Ductility is increased and strength decreased by recrystallization annealing. Hardening and low tempering reversed these changes in properties. High temperature heat and mechanical working with hot stamping allowed the achievement of a high level of strength without ductility increases. Impact toughness was practically independent of initial porosity. References 3: 2 Russian, 1 Western.

6508/12955

CSO: 1842/187

UDC 621.762.2

THE EFFECT OF THE PARTICLE SIZE OF ATOMIZED POWDER ON THE PROPERTIES OF SINTERED SPECIMENS

Moscow STAL in Russian No 2, Feb 86 pp 89-90

[Article by I. V. Zheltyakova, Ya. M. Turetskiy, I. A. Gulyayev, V. V. Kuleshov and V. A. Vdovenko, Central Scientific Research Institute of Ferrous Metallurgy and Brovary Powder Metallurgy Plant]

[Abstract] The effect of the particle size of air-atomized iron powder on its technical properties and on the mechanical properties of sintered specimens made from this powder was studied. The powders were crushed and pulverized in stages to make 0.4 mm and 0.2 mm particle sizes. Artificial mixtures varying in particle size were also made. Two series of tests were carried out. Powders with larger particles yielded compacts that had lower compactness after filling the dies, poorer yield, better moldability, and greater strength. The powder compacts were then sintered at 1150°C for two hours in hydrogen as Corex was charged into the upright furnace. The strength and plastic properties of the sintered specimens tended to deteriorate as particle size increased, but the absolute values of this deterioration were not significant. References 2: both Russian.

13050/12955
CSO: 1842/165

UDC 542.65

GROWTH AND LUMINESCENT PROPERTIES OF BULK CRYSTALS OF INTRINSIC ZnSe WITH P-TYPE CONDUCTIVITY

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 3, Mar 86
(manuscript received 25 Jun 84) pp 387-391

[Article by M. Ye. Agelmenev, A. D. Levit, Ye. I. Panasyuk and N. V. Serdyuk, Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences]

[Abstract] Bulk crystals of intrinsic ZnSe with p-type conductivity and dominant luminescence in the blue region of the spectrum were successfully grown by the static variant of the Markov-Davydov sublimation process with the growing crystal in fixed position relative to reactor and heater. In this process both section and profile of the clearance between crystal and reactor wall are in an interdependence relation with the thermodynamic properties of the crystal material and the temperature profile in the reactor. The crystal growth was accordingly monitored on this basis, with the concentration gradient in the vapor phase serving as indicator of the clearance profile. With the source temperature varied from 1370 K (below 1400 K) to 1500 K (above 1400 K) and the mean rate of crystal growth along the axis within 130-140 $\mu\text{m}/\text{h}$, the temperature profile revealed three zones of crystal growth: zone I of a concave crystallization front and narrowing clearance, zone II of an approximately uniform clearance width and zone III of a convex crystallization front and a widening clearance. Comparative measurements were made on crystals grown from raw material and from refined material respectively. Cathodoluminescence at 77 K and 300 K was measured with an electron beam having a maximum energy of 15 keV and a current density of 10^{-7} A/cm^2 as excitation source, and using an MDR-3 monochromator. Photoluminescence at 10 K as well as at 77 K and 300 K was measured with an LGI-211 laser as excitation source, and using an MDR-23 monochromator. Photoconduction was activated by means of an SI-10-300 lamp. The polarity of the thermal emf was determined and the Hall effect was measured with Degussi silver paste as contact material. The results indicate that yellow-orange luminescence of crystals grown from raw material can be shifted to blue luminescence by purification of that raw material and control of the deep energy level ($E = 0.7 \text{ eV} + E_V$) close to that of singly charged zinc vacancy. The authors thank A. N. Georgobiani and V. K. Yakumin for helpful consultations, and V. L. Prohorova for assistance in growing the crystals. References 16: 5 Russian, 11 Western (1 in Russian translation).

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GROWING Mg-DOPED ZnSe CRYSTALS

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 3, Mar 86
(manuscript received 2 Jul 84) pp 392-394

[Article by M. P. Kulakov and A. V. Fadeyev, Solid State Physics Institute, USSR Academy of Sciences]

[Abstract] Crystals of Mg-doped ZnSe were grown by the Bridgman method at rates of $(0.8-8.0) \cdot 10^{-4}$ cm/s in an argon atmosphere under a gage pressure of 2 MPa. Doping was done by adding MgSe salt, synthesized by fusion of high-purity Mg and Se, to raw ZnSe powder refined to an impurity content not exceeding 10^{-3} wt.% ($5 \cdot 10^{-5}$ wt.% Mg). The effect of doping on the crystal structure and its lattice parameter as well as on the energy gap and the optical properties within the transparency range was measured, while the Mg content was monitored by atomic-emission analysis with a sensitivity of 10^{-5} wt.% and within 10% accuracy. The lattice parameter was measured on Debye-grams taken by an RKD-86 camera with ± 0.003 Å precision. The energy gap was determined from the location of the edge in the spectrum of fundamental absorption, that edge having been determined with a Specord M-40 spectrometer and through extrapolation of the absorption coefficient. The edges of lattice absorption were recorded with a Specord 75IR spectrometer in the $1200-400$ cm⁻¹ range and with a Perkin-Elmer spectrometer in the $500-200$ cm⁻¹ range. Measured also were the dislocation density on cleavage surfaces and the birefringence with a Berek compensator. Crystals 3-6 mm in diameter and weighing 0.1-0.3 kg were grown with the Mg content varied over the 0.001-4.0 wt.% range, corresponding to the $0 - x - 0.21$ range of $Zn_{1-x}Mg_xSe$ compositions. The crystals with up to 1 wt.% Mg had a spaleritic form, the crystals with higher Mg content up to 3 wt.% ($x = 0.18$) had an incomplete wurtzite \rightarrow sphalerite transformation, and the crystals with a still higher Mg content had no cubic phase at all but multiple cracks caused by excessive stresses.

References 11: 8 Russian, 3 Western (2 in Russian translation).

2415/12955
CSO: 1842/192

UDC 546.47'23

CHANGES IN COMPOSITION OF ZnSe CRYSTALS DURING ZONE REFINING

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 3, Mar 86
(manuscript received 22 Jun 84) pp 395-398

[Article by N. N. Kolesnikov, M. P. Kulakov and A. V. Fadeyev, Solid State Physics Institute, USSR Academy of Sciences]

[Abstract] The process of ZnSe crystal growth in a graphite crucible in an argon atmosphere is analyzed theoretically on the basis of a diffusion mechanism accompanying dissolution and evaporation. Diffusion of Zn and Se vapors through the permeable crucible walls into the argon atmosphere during crystallization of the melt causes the concentration of the superstoichiometric component in the melt to change. The mathematical description of this process is based on the simplifying assumptions that both width and volume of the melting zone as well as the area of the evaporation surface remain constant, that diffusion within the solid phase and evaporation from its surface are negligible, that the distribution of the superstoichiometric component has a form factor which remains constant and independent of the concentration, and that both liquid-solid equilibrium and $B_n \rightleftharpoons nB$ equilibrium in the gas at the liquid-gas boundary are reached instantaneously, the external pressure of argon being much higher than the pressure of Zn and Se vapors, this latter pressure dropping to zero at the crucible walls. An equation is derived accordingly for the concentration gradient of the superstoichiometric component resulting from convective removal of the vapors by the argon and their condensation on the crucible walls. This equation accounts for atomic dissolution and evaporation in the melt simultaneously with molecular diffusion of the vapors in the gas. The first melting zone is considered, first when stationary with rising partial pressure of the component above the melt and then in motion under a pressure gradient, whereupon directional crystallization of the melt at the end of the ingot is considered. These theoretical relations, together with technological and experimental data, allow predicting the change from a melt with a superstoichiometric component to a crystal with a stoichiometric composition requiring excess zinc in the raw material.

References 6: 2 Russian, 4 Western (2 in Russian translation).

2415/12955

CSO: 1842/192

TREATMENTS

IZHORA PLANT 5000-MM ROLLING MILL ATTAINS DESIGN CAPACITY AHEAD OF SCHEDULE

Moscow SOTSYALISTICHESKAYA INDUSTRIA in Russian 15 May 86 p 1

[Article by V. Likhacheva: "Ahead-of-Schedule Finish of Workers' Relay Race"]

[Text] The Izhora rolling mill workers have achieved an important labor victory. They have attained the design capacity of the first stage of the giant 5000-mm mill ahead of schedule.

There is a holiday in the 400-meter long plate rolling-mill bay. A monthly production rate that corresponds to the design capacity of the mighty mill has been achieved. The people behind the control desk of the production line are the operators of A. Titov's brigade.

"A new lot of heavy ingots is arriving" -- says the brigade leader. "Our suppliers, the metallurgists of the association, produced them. The ingot quality is high."

The next forged slab is now being heated in a special furnace to 1300-1400 degrees before rolling. The 5000-mm mill is a modern production line equipped with the latest high-productivity equipment. It was built to produce unique products. It is the first in the country to roll large-size plates up to five meters wide and from 10 to 450 millimeters thick. The weight of the plates is as high as 90 tons. The plates are much more economical [effekivneye] than forged plates.

A steel slab, glowing with unbearable heat, slid into the four-high stand. This is the powerful heart of the mill. It is 17 meters high and weighs 5,500 tons. While the powerful rolls labor with the next plate, let us take a look at the work schedule of the plate mill. The chart shows how unceasingly the capacity line of the 5000-mm mill rises.

"At first, according to calculations, the design capacity was supposed to have been attained in August" -- says the secretary of the shop party bureau A. Garmanov. "But the builders, installers, and operators, utilizing the advantages of the "workers' relay" commissioned the new mill train ahead of schedule.

During the 27th CPSU congress, an amendment appeared in the socialist obligations of the Izhora Plant collective. The rolling mill workers had decided to attain the design capacity by the 15th of May. But they beat even this deadline.

"We find all of our reserves in the shops of our association" --says A. Garmonov. A large part of the equipment is made at the Izhora Plant. But what is important is that the search for the reserves is aimed above all at improvement of product quality. For example, ultrasonic quality control will be introduced in the near future.

"This method makes it possible to detect the finest defects in the steel plate" -- adds the supervisor of the nondestructive testing laboratory R. Tabakman. "Ultrasound unerringly reveals defects as small as a kopek on the huge surface of the plate."

In creating such an accurate monitoring device the plant specialists were assisted by scientists from the Leningrad Electrical Engineering Institute imeni V. I. Ulyanov-Lenin.

The four-high stand released a steel plate from its embrace. Senior roller V. Lugovoy and his helper A. Timofeyev measure its thickness with special Vernier calipers. Everything is according to specs. After cooling, the huge plate will be shipped to the power machinery builders. And a new steel bar held by giant claws is suspended above the mill.

12973/12955
CSO: 1842/209

UDC 699.14.018.85

CHANGE IN THE GRAIN-SIZE NUMBER AND PROPERTIES OF CHROMIUM-MOLYBDENUM-VANADIUM STEEL DEPENDING ON MICROALLOYING

Moscow STAL in Russian No 2, Feb 86 pp 84-88

[Article by K. A. Lanskaya, L. V. Kulikova, G. G. Guley and V. V. Yarovoy, Central Scientific Research Institute of Ferrous Metallurgy]

[Abstract] The effect of microadditions of zirconium, boron, rare-earth metals, and titanium on the grain-size number, phase composition, microstructure, and properties of 12Kh1MF chromium-molybdenum-vanadium heat-resistant steel was studied. The changes in the austenitic grain-size number were studied on a high-temperature Reichert microscope within a temperature range of 850-1250°C at intervals of 50°C. The heating rate was 10°C per second. The actual content of zirconium, boron, and titanium was determined by spectral analysis; the actual content of rare-earth metals by spectrochemical analysis. In order to establish the phases affecting the growth kinetics of the austenitic grain, specimens of the microalloyed steel were heated to 950, 1000, 1050, 1100, 1200, and 1250°C and water-quenched. The specimens then underwent chemical-phase, electron microscopic, and micro-X-ray spectral analysis and X-ray crystallography. Microadditions of up to 0.0006% boron, 0.125% zirconium, and 0.038% rare-earth metals contributed to the growth of the austenitic grain in 12Kh1MF steel within a temperature range of 850-1050°C. At higher temperatures, the largest grain was found in steel with the minimum concentrations of microadditions. These microadditions also contributed to the refinement of the basic carbide and carbonitride hardening phase and to the formation of a baynate structure, and the uniform distribution of baynate regions and carbide and carbonitride phases. The addition of 0.004-0.15% titanium either inhibited grain growth or reduced grain size throughout the entire temperature range studied. The short- and long-term strength of the steel was increased with the addition of zirconium, boron, and rare-earth metals, whereas the addition of titanium led to the deterioration of its strength. References 6: all Russian.

13050/12955
CSO: 1842/165

UDC 546.681.191.1:539.216.2

EFFECT OF NONCONTROLLABLE IMPURITIES ON ELECTRICAL PROPERTIES OF GaAs FILMS
GROWN BY MOLECULAR-BEAM EPITAXY

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 3, Mar 86
(manuscript received 16 Jun 84) pp 371-375

[Article by G. G. Dvoryankina, V. F. Dvoryankin, G. Varaksin, A. G. Petrov,
A. A. Kudryashov, V. V. Shemet and M. L. Yassen, Radio Engineering and
Electronics Institute, USSR Academy of Sciences]

[Abstract] A study of GaAs films grown by molecular-beam epitaxy in a single-chamber apparatus was made for the purpose of determining the effect of non-controllable impurities. Intrinsic p-type GaAs [100] films (electrical resistivity $\rho \sim 0.1$ ohm·cm, hole concentration $p \sim 10^{16}$ - 10^{17} cm $^{-3}$) were grown on Cr-doped GaAs [100] substrates (electrical resistivity $\rho \sim 10^6$ ohm cm) at a temperature of 830-850 K, the temperatures of the Ga source and the As source being 1250-1270 K and 570-600 K respectively. The growth rate was varied over the 0.6-1.0 $\mu\text{m}/\text{h}$ range. Concentration and mobility of holes in the films were measured by the Hall method, the results revealing a wide variance of electrical properties among films grown under the same conditions: electrical resistivity $\rho \sim 0.1$ - 100 ohm·cm, hole concentration $p \sim 10^{14}$ - 10^{17} cm $^{-3}$, hole mobility $\mu_{300\text{K}} \sim 100$ - 400 cm $^2/(\text{V}\cdot\text{s})$. A chemical and emission spectrum analysis of GaAs, Ga, and As vacuum condensates sampled from the apparatus revealed Cr, Mn, Co, Ni, Cu in various components of the apparatus as likely causes of this variance. Next Sn-doped n-type GaAs [100] films were grown with the Sn source at a temperature of 1070 K and with the apparatus modified so as to eliminate those noncontrollable impurities. The concentration dependence of the electron mobility at various compensation levels ranging from 0.4 to 0.9 was measured at 300 K and at 77 K. Here the variance and the deviation from theoretical values are attributable to the p-GaAs [100] buffer layer between n-GaAs [100] film and substrate. The authors thank G. V. Gerasimova for producing the substrates and A. V. Zigunskaya for performing the chemical-spectral analysis. References 12: 3 Russian, 9 Western.

2415/12955
CSO; 1842/192

UDC 669.046.56

PURIFICATION ANNEALING OF NICKEL OXIDE AND FERROCHROMIUM CARBIDE MIXTURES

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 3, Mar 86 (manuscript received 23 Sep 85) pp 9-12

[Article by A. S. Istomin, D. I. Ryzhonkov and V. A. Kolchanov, Moscow Steel and Alloys Institute]

[Abstract] Interaction of NiO and $(\text{CrFe})_x\text{C}_y$ during linear heating at a rate of $5.7^\circ\text{C}/\text{min}$ to 1350°C and isothermal annealing at 1350°C was studied in a "Setaram" thermogravimetric apparatus with alundum crucibles, for the purpose of determining the mechanism of the NiO reduction process. Mixtures of chemically pure NiO and ferrochromium carbide containing 7.97 wt.% C+ 71.0 wt.% Cr, with three different molar ratios of oxygen to carbon (1.0, 1.3, 1.5), were pulverized for 30 min in an agate mortar. Annealing was done in an inert atmosphere and in vacuum. The concentration of CO in the evolving CO+ CO₂ gas mixture was measured with a chromatograph. The exothermic effect, release of heat during reduction of NiO, was found to begin at 512°C , peak at 1095°C , and end at 1290°C . An x-ray phase analysis of the end product has revealed Cr₂O₃ along with Ni and NiO. A quantitative analysis of the chemical reactions occurring in the process indicates that reduction of NiO by ferrochromium carbide proceeds in two stages: reduction by carbon and chromium within the 1050 - 1080°C temperature range followed by reduction of Cr₂O₃ by residual carbon at higher temperatures. References 4: all Russian.

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CSO: 1842/197

UDC 621.771

LOW-FREQUENCY VIBRATORY ACTION ON CRYSTALLIZING MELT IN MODEL EXPERIMENT

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 3, Mar 86 (manuscript received 1 Mar 85) pp 42-47

[Article by A. F. Vishkarov, Yu. V. Kryakovskiy, O. S. Pankratov, A. A. Safronov and V. I. Chukhlov, Moscow Steel and Alloys Institute]

[Abstract] A model experiment was performed, low-frequency vibrations being applied to a melt during its crystallization for the purpose of producing a homogeneous ingot. Model substances (camphene, diphenyl, hyposulfite) were cast in rectangular molds with one pair of parallel walls made of an optically translucent but thermally insulating material. The main effect of vibrations was found to be intensified crystal seeding, an avalanche process manifested by loss of thermogravitational convection and symmetrical spreading of the crystal cloud, followed by enlargement of the crystals and their merger into irregular conglomerates eventually precipitating to the bottom of the mold. The process was compared with that in control melts either not vibrated at all or vibrated at all or vibrated together with the mold. Two trends were consistently observed in the experimental melts, namely a temperature rise after avalanche crystal seeding had begun and continuation of crystallization at the higher temperature with the melt remaining in "suspension" during precipitation of crystals. Formation of the new phase, the crystalline solid phase, is thermodynamically associated with a high density of its surface energy and with subcooling of the parent phase. Hydrodynamically it is associated with wave motion of the parent phase and cavitation, which tends to narrow down the zone of columnar crystallization and to localize large shrinkage defects in the ingot region adjacent to the external vibration source. References 7: 5 Russian, 2 Western (1 in Russian translation).

2415/12955
CSO: 1842/197

UDC 669.187.2:621.774.56

PRODUCING GLOBULAR GRAPHITE IN CAST IRON BY ELECTROLYSIS OF SLAG

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 3, Mar 86 (manuscript received 29 Aug 85) pp 51-54

[Article by V. A. Grachev, N. A. Gorelov and N. S. Pavlenko, Penza Polytechnic Institute]

[Abstract] Electrolysis of slag with a high magnesium content is proposed for producing globular graphite in iron melt before casting. The effectiveness of this process has been established experimentally in a semiindustrial furnace with a single electrode drawing current from a TSD-1000 single-phase 71-78 V - 71 kVA transformer through a rectifier. First there was tried the 43% CaF_2 + 43% MgF_2 + 9% MgO + 5% NaF slag already known to yield a high-strength iron but not capable of globularizing the graphite. A new electrolytic process was subsequently developed, with the upper surface of the slag insulated from the oxidizing atmosphere by a layer of carbon and with the tank partitioned so that electric current passing through will electrolyze the slag in the larger compartment and only heat the slag in the smaller "control" compartment. Good results were obtained in this apparatus with 20% CaO + 80% CaF_2 slag, requiring a carbon barrier to prevent attrition of C, Si, Mn and promote attrition of sulfur, but better results were obtained with 40% MgO + 40% MgO + 40% MgF_2 + 20% CaF_2 slag using a carbon strike (1:1 carbon-to-slag ratio). Direct current yields better results than alternating current. References 3: all Russian.

2415/12955
CSO: 1842/197

UDC 621.8.001.5:539.3

STRESSED STATE OF KEYLESS COUPLINGS IN ROLLING MILLS UNDER TRANSVERSE FLEXURE

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in
Russian No 3, Mar 86 (manuscript received 27 Aug 84) pp 63-66

[Article by B. A. Obodovskiy and M. N. Gofman, Metallurgy Institute]

[Abstract] For an explanation of breakage in wobbler couplings between main shafts in rolling mills, the problem of transverse flexure is formulated for a shaft with two parallel flats under a transverse force acting parallel to the flats through the center of a free cross-section. The problem is solved with the mathematical apparatus of the complex variable, by the method of conformal mapping. The algorithm of the solution has been programmed on a YeS-1022 computer. The approximate Zhurakovskiy formula for shearing stresses underestimates the maximum shearing stress by less than 6% when the ratio H/D of shaft width (across flats) to shaft diameter is small or large, but the error exceeds 10% when this ratio is within the intermediate range. The formula overestimates the minimum shearing stress by 3-6% over the entire range of the H/D ratio. References 5: all Russian.

2415/12955

CSO: 1842/197

UDC 669.14.018.252:621.762

EFFECT OF HOT EXTRUSION ON STRUCTURE AND PROPERTIES OF POWDER-METAL HIGH-SPEED TOOL STEEL

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 3, Mar 86 (manuscript received 18 Sep 84) pp 86-90

[Article by V. O. Guk, L. P. Sergiyenko, Ye. P. Tolkacheva and Yu. F. Luzin, Central Scientific Research Institute of Ferrous Metallurgy]

[Abstract] Hot extrusion of ROM2F3-MP powder-metal high-speed tool steel was studied, for the purpose of determining the dependence of its structure and mechanical properties on the extrusion temperature and the extrusion factor. For comparison, hot extrusion of standard 10R6M5-MP powder-metal steel was also included in the study. The extrusion temperature and the extrusion factor were varied over the 1000-1150°C range and from 5 to 20 respectively, depending on the extrusion rate and pressure, 1150°C and 20 corresponding to the maximum allowable load on a cutting tool. The temperature range of maximum plasticity, percentage elongation and percentage reduction, was found to be 1050-1150°C for ROM2F3-MP steel as well as for 10R6M5-MP steel. After extrusion, ingots of both steels were heat treated by heating to 860+20°C and holding at temperature for 3 h with subsequent cooling to 600-550°C and then to room temperature in air. Microstructural examination and mechanical tests have revealed that both austenite grain size and hot plasticity increase with higher extrusion temperature. Density of the steel and size of the carbide phase as well as flexural strength and impact strength depend on the extrusion factor but not on the extrusion temperature, while hardness does not depend on the extrusion factor. Optimum for ROM2F3-MP steel are an extrusion temperature within the 1075-1150°C range and an extrusion factor not smaller than 10. References 4: all Russian.

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CSO: 1842/197

UDC 548.55

IMPROVING QUALITY OF CAST SINGLE CRYSTALS OF YuNDK35T5AA ALLOY

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No. 3, Mar. 86. (manuscript received 20 Jun. 85) pp. 148-150

[Article by M. V. Pikunov, Ye. V. Sidorov and I. V. Belyayev, Moscow Steel and Alloys Institute]

[Abstract] Only 3-12% of single crystals of the YuNDK35T5AA alloy cast by the Bridgman method are nondefective, without parasitic crystals included in their structure. This is attributable to deficiencies of the technology, melting down polycrystalline preforms and seeding the melt with a small single crystal while the heater climbs. In such a process unmelted fragments of the preform are likely to drop down and also become seeds. An analysis based on analogy to the Cu+ 10% Ni alloy with a similar crystallization temperature range and with a dendritic structure, indicates that liquidation of dendrites is the likely mechanism leading to precipitation of fragments and seeding of parasitic crystals. It therefore is necessary to ensure complete melting of the entire preform before seeding. With 130-140 mm long preforms melted by steady heating, 30 nondefective single crystals of the YuNDK35T5AA alloy were produced not only without rejects but 10 of them also at a rate much faster than in the conventional process: 300 mm/h rather than 90 mm/h at which the other 20 were grown. References 2: both Russian.

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CSO: 1842/197

WELDING, BRAZING AND SOLDERING

UDC 621.791.3:621.791.72

USE OF XENON ARC LAMP LIGHT ENERGY TO SOLDER PIPE-FLANGE TYPE JOINTS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 3, Mar 86 pp 1-2, 26

[Article by Candidate of Technical Sciences M. I. Oparin, Engineer N. S. Pronin, Engineer V. S. Mameyev, Engineer V. A. Frolov and Engineer V. E. Gorelov, Moscow Aviation Technical Institute imeni K. E. Tsiolkovskiy]

[Abstract] The use of xenon arc lamp light energy to solder pipe-flange joints has a number of advantages over traditional methods, including effective heating of metals with different thermal and electromagnetic properties, contactless input of energy to the parts being joined and the possibility of soldering in air, in a controlled gas medium or in a vacuum. Studies of the soldering process using this method were performed on type L63 brass pipe with PSr40 solder and PV209 flux. The radiant heater used included a radiation concentrator consisting of an elliptical metal reflector containing a DKSSHRB-10,000 10 kW xenon arc lamp, an adjustment unit for precise focusing, an electromagnetic gate and a lamp ignition section. It was found that a focal spot with radiant energy flux density distributed in a saddle shape was most effective. References 6: all Russian.

6508/12955
CSO: 1842/181

UDC 621.791.72

SOLDERING OF SPRING CONTACTS BY XENON ARC LAMP LIGHT BEAM

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No. 3, Mar 86 pp. 2-3

[Article by Candidate of Technical Sciences S. A. Fedorov (Moscow Aviation Technical Institute imeni K. E. Tsiolkovskiy), Candidate of Technical Sciences V. V. Grinin, engineer V. V. Ovchinnikov, Engineer V. Ye. Korotkov, Engineer Ye. A. Borisov and Engineer M. A. Filippova (Znamya truda Machine-building Plant, Moscow)]

[Abstract] The purpose of this work was to study and develop the technological process of soldering electric spring contacts using the light beam from xenon arc lamps, achieving local rapid heating, contactless application of energy to the product, stable energy parameters and allowing automation of the process with a broad range of heating temperatures available. The radiation concentrator used was an ellipsoid reflector 358 mm in diameter and the radiation source was a 5-kW xenon arc lamp. Parts to be soldered were initially degreased with acetone and held in their assembled position by a special bracket. A ring of solder 0.8 mm thick was placed between the spring and the flange. Zinc chloride flux was used. The studies showed that a temperature gradient develops between the peripheral and central portions of the flange, with the maximum gradient around the periphery, as a result of the specifics of the focusing of the light beam and the rapid heat loss in the flange. The technology developed involved soldering by application of 6-8 second bursts of current to the lamp. The total time required to solder one contact was 15-18 seconds. References 2: both Russian.

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UDC 621.791.3:66.085

SLU-1 LIGHT BEAM INSTALLATION FOR SOLDERING OF ELECTRIC POWER APPARATUS ELEMENTS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 3, Mar 86 pp 3-4

[Article by Engineer V. V. Ovchinnikov, Candidate of Technical Sciences V. V. Grinin, Candidate of Technical Sciences S. A. Fedorov, Engineer V. Ye. Korotkov, Engineer A. G. Polovnikov and Engineer S. V. Molochkov]

[Abstract] A metal reflector for xenon-arc lamp soldering has been developed with the following geometric parameters: diameter 300 mm, depth 200 mm and included angle 260 degrees. The reflector is made of AK4-1 aluminum alloy, which has good strength and light weight, good reflectivity and can easily be worked by cutting tools. The concentrator is mounted on a column in a bracket allowing the concentrator and brackets to be mounted either above or beneath the work. The 3-10kV xenon arc lamps used require air and water cooling. The SLU-1 installation has been tested in the soldering of electric spring contacts, cable terminals, contact plates and other electric power apparatus elements, achieving good results. The installation can achieve annual savings of 21,000 rubles by improving productivity of the process and reliability.

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LASER WELDING MODES PROVIDING IMPROVED CORROSION RESISTANCE OF WELDED JOINTS
IN THIN SHEETS OF TYPE 08Kh15N5D2T STEEL

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 3, Mar 86 pp 4-6

[Article by Doctor of Technical Sciences V. G. Fedorov, deceased, Engineer V. M. Shanchurov, Candidate of Technical Sciences V. V. Grinin, Candidate of Technical Sciences V. V. Alekseyev, Engineer N. F. Arbuzov and Candidate of Technical Sciences V. B. Lashchevskiy]

[Abstract] The purpose of this work was to develop conditions for laser welding providing improved corrosion resistance in joints of 08Kh15N5D2T sheet steel containing 0.07% C and 0.13% Ti. Studies were performed on specimens 2 mm thick. The studies showed that the metal in the area of thermal influence, heated to 440-480 and 565-580°C, had increased corrosion cracking tendencies, while the maximum corrosion cracking tendency was observed in the area heated to 590-610°C. The zone of carbide segregation corresponds to that area heated to 550-750°C. If the time the area heated to 600°C spends at temperature over 500°C is over 0.7s, electrochemical activity of the metal increases greatly, reaching a maximum if this time exceeds 2 seconds. Corrosion resistance can be improved by using laser welding modes such that the time the metal spends at over 500°C is not over 1 second, which is achieved by laser welding speeds of $25 \cdot 10^{-3}$ m/s or more. References 8: all Russian.

6508/12955
CSO: 1842/181

UDC 621.791.052:539.4

CRACK FORMATION AND MICROSTRUCTURE OF LASER-MELTED CHROME-BORON-NICKEL ALLOYS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 3, Mar 86 pp 6-8

[Article by Candidate of Technical Sciences A. N. Grezev and Candidate of Technical Sciences A. N. Safonov]

[Abstract] A study is made of the influence of the conditions of laser melting on crack formation and microstructure in the fusion zone and surfaced metal. Experiments were performed on a "Katun" laser unit with a radiated power of 1 kw, surfacing rate of 4.5-15 mm/s, focal length of 350-360 mm and laser beam scanning amplitude of 2.5 mm, the substrate was hardened high-tempered EI107 steel. Self-fluxing Ni-Cu-B-Si alloys in granulated powder form with particle size 40-160 μ m or 60-400 μ m were used. Ferroalloys at 3%, as well as boron carbide and carbon, were added to study the influence of various chemical elements on crack formation and the microstructure of the surface metal. The crack formation tendency was found to increase with increasing speed of surfacing as well as increasing content of carbon and particularly boron in the filler materials. The addition of 3% ferrotitanium, ferrovanadium and ferrosilicon decreased the crack formation tendencies significantly by forming a plastic γ phase in the surfaced metal capable of relaxing the high temperature stresses arising during cooling. References 4: 3 Russian, 1 Western.

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TECHNOLOGICAL SPECIFICS OF LASER POWDER SURFACING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 3, Mar 86 pp 8-10

[Article by Candidate of Technical Sciences V. Ye. Arkhipov and Engineer Ye. M. Birger, Remdetal All-Union Scientific Production Association]

[Abstract] This article presents results of studies of the influence of the technological parameters of surfacing and of the initial state of the powder used for surfacing on the structure and properties of the coatings produced. The powder was applied as a paste in OETS organic glue with subsequent heating by a CO₂ laser rated at 1 kw. Chrome-boron-nickel-silicon self-fluxing type SNGN powders and alloyed FBKh-6-2 cast iron powders were used. Calculations indicated that the actual surfacing time of the coatings of a given thickness is significantly greater than the time required to melt the material and heat it to the temperature necessary to form a metallurgical bond with the substrate. Most of the time of action of the laser is expended in heating the upper layer of the powder to the temperature at which the coefficient of absorption increases to 100%, which occurs at or near the melting point. The results of the studies allowed certain peculiarities of the laser melting process to be determined, allowing a significant improvement in the technology and determination of areas of application for various groups of parts. Test-stand and full-scale testing of a large group of motor vehicle and tractor parts with surfaces subject to cyclical impact loading showed positive results. Laser powder surfacing has thus been demonstrated to be effective as a means for increasing the operating life of parts and providing improved physical-mechanical and corrosion properties for the surfaces of metal parts. References 3: all Russian.

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CSO: 1842/181

UDC 621.791.72.03:621.373.826

"LATUS-31" LASER TECHNOLOGICAL INSTALLATION

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 3, Mar 86 pp 10-11

[Article by Engineer V. I. Trubitsin, Engineer V. S. Aleynikov, Engineer Ye. O. Pskovitinov, Engineer P. I. Savilov, deceased, Candidate of Technical Sciences A. F. Khudishev, Candidate of Technical Sciences O. S. Lisogorov and Engineer O. A. Lyubarskiy]

[Abstract] The "Latus-31" laser technological installation was developed on the basis of a "Karat" compact convective laser with radiated power up to 1.5 kw utilizing longitudinal pumping of the gas mixture and gas discharges in dielectric cylinders. The "Latus-31" is a modular device, including the "Latus-30" base model and an electromechanical actuating mechanism with power supply to move the parts being worked. The device is intended for both seam and spot welding of metal 0.2-2 mm thick in a protective gas medium in single or multiple mode operation. The high power density of the laser beam assures high speed welding of metals and high productivity.

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UDC 621.791.754'293

AUTOMATIC ARGON-ARC WELDING OF PARTS OF AMTs ALLOY AND 12KH18N10T STEEL
WITHOUT BIMETALLIC ADAPTERS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 3, Mar 86 pp 14-15

[Article by Engineer A. A. Osokin and Engineer D. N. Ganelin]

[Abstract] A technological process has been developed for welding of 12Kh18N10T steel and AMTS alloy, consisting of the following operations: tinning of the surface and end of the edge of the steel part with POS-61 solder; application of FA-1T flux to the edges of the steel and aluminum parts; assembly of the edges to be welded to produce a lap joint, with the steel part immediately under the tungsten electrode; additional application of FA-1T flux to the outer surface of the aluminum edge and the end of the steel edge; welding of the part with DC in a longitudinal alternating magnetic field to limit the depth of melting of the steel and provide flow of the aluminum at the steel end. The use of FA-1T flux and preliminary tinning of the welded surfaces of the steel edge assures good quality lap joints equal in strength to the AMTS alloy. There is a zone of interdiffusion of the elements of the welded materials 60-80 μm wide and intermetallide inclusions in the seam metal on the aluminum side. References 5: all Russian.

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CSO: 1842/181

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INFLUENCE OF HYDROGEN ON PROPERTIES OF WELDED JOINTS IN PIPES OF NICKEL-FREE CORROSION RESISTANT STEELS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 3, Mar 86 pp 22-23

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[Abstract] A study was made of the influence of hydrogen on properties of welded joints in ferritic 08Kh18T1 steel containing up to 0.08% carbon, 16-18% chromium and 0.6-1.0% titanium. Two methods were used to protect the weldpool and the cooling seam metal: The first batch of 33x1.5 mm pipe was welded using a standard argon-arc installation in which argon to protect the weldpool from saturation with gasses from the air is fed into a circular gap between the nozzle of the burner and the electrode; to decrease the gas saturation of the metal observed with this method, devices were developed for additional protection of the weldpool with argon during welding and of the seam as it cooled. A nozzle on the welding head was designed which provided laminar flow of the argon at low speeds of the gas jet, with the argon flowing through metal chips and a fine-mesh screen. An additional device approximately 200 mm long was installed on the seam to continue the flow of argon as the seam cooled. Argon was fed beneath the pool and filled the inner cavity of the pipe to protect the inner surface of the weldpool and the cooling seam. The use of these devices on a second test batch of specimens significantly decreased the content of hydrogen and oxygen in the seam metal, greatly reducing the number of specimens with low relative elongation.

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FORMATION OF MICRORELIEF ON THE SURFACE OF TITANIUM ALLOYS DURING DIFFUSION WELDING

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[Article by Engineer M. B. Nikgolov, Candidate of Technical Sciences V. V. Peshkov and Candidate of Technical Sciences V. N. Rodionov]

[Abstract] A study is presented of the formation of the microrelief on the surface of titanium alloys annealed under conditions imitating the process of diffusion welding. Studies were performed on specimens 16 mm in diameter and 10 mm high of VP5, OT4, VT6, VT2, VT16 and VT22 alloys, all with initial fine grained structures except VT16, which had small plate structure. The process of growth of the relief was evaluated based on the change in surface roughness parameter as measured by a profilometer. Intensive development of microrelief is considered to represent deformation of the surface under the influence of internal stresses, the rate of this deformation being significantly greater than the deformation of titanium alloys under the influence of external stresses during welding with little application of force. Before welding pressure is applied, elements to be joined should be annealed separately for 15 to 30 minutes at the $\alpha + \beta \rightarrow \beta$ conversion temperature to intensify the process of diffusion joint formation as a result of deformation of the contact surfaces. References 10: 9 Russian, 1 Western (in Russian translation).

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MISCELLANEOUS

MAGNETIC LIQUIDS -- THE SPECTRUM OF POSSIBILITIES

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[Article by V. Alekseyev]

[Text] The soot-black oily liquid behaved literally without regard for the laws of gravity. Suddenly it crept up the wall, threatening to escape from the laboratory vessel. A laboratory assistant changed the magnet, and a long, thin spike grew on the smooth surface. A little manipulation, and it became transformed into an intricate flower. These miracles are shown at the Physics Institute of the Latvian Academy of Sciences in order to illustrate more graphically the astonishing properties of magnetic liquids -- solutions or suspensions consisting, for instance, of kerosene and a fine-grain magnetic powder, whose particle size does not exceed 80 angstroms.

We know from school that electric current appears in a conductor when the conductor moves in a magnetic field. And if a tube containing a conductor is placed in a magnetic field and a temperature gradient is created between the ends of the conductor, which will set the liquid in motion, the tube will produce a current. The idea of a generator without moving mechanical parts -- a generator that can be used anywhere waste heat is produced -- fascinated the physicists. They created a liquid magnet, but the idea has been undercut by the low efficiency of the generator. And according to the thermophysics laboratory director E. Blum, this idea will hardly be realized in this century. But let us not make predictions; it is sufficient that the spin-offs from the idea have already assumed an independent existence.

The engineers were the first to turn their attention to the magnetic liquids. They decided to use them in place of mechanical seals, packings, and glands. The thought is elegant and simple. In place of a seal a shaft circumference is encircled by a groove filled with a magnetic liquid, and small magnets are placed along the opening in which the shaft rotates. The liquid, which is retained by the magnetic field, securely closes the gap and also provides lubrication.

As it frequently happens, the exotic method of sealing was first tested in space technology. Later specialists working in the area of semiconductor and fine chemical technologies turned their attention to it. Unlike the traditional seals, the magnetic-liquid seals do not break down; that is,

they do not produce impurities that can interfere with very delicate technological processes. And now people in a number of design organizations are already studying, at the request of the microbiologists, sealants that are capable of working in corrosive media at high temperatures.

And here is another area of application, the story of which it is simplest to begin with an example from daily living. How can one collect spilled small nails? Well, by simply passing a magnet over the floor; the nails will adhere to it. Ukrainian scientists have proposed a way to combat accidental petroleum spills by a similar method: Treat the spill with a magnetic liquid based, for instance, on the same kerosene, and pick up the spill with a magnet. Judging by the results of the first trials, the method may find use in ports or in resort areas of the Black and Baltic Seas.

And now attention radio buffs! [melomany] Everyone knows that the power of even home radio has been rising, and at the same time there is an increasing clamor to miniaturize it. Microelectronics has made it possible for magnetic sound recorders, receivers, and amplifiers to "slim down". But the designers give up when it comes to dynamic speakers. It is necessary to use large magnetic systems, and particularly because acoustical coils can not withstand temperatures above 120 degrees because the insulation of the wires breaks down. Air is a poor thermal conductor, and now the Physics Institute people have proposed the use of a magnetic liquid for cooling the coils. Its thermal conductivity is 7-8 times higher; that is, it is possible to supply considerably more power to the speakers without the risk of overheating. At the same time their frequency characteristics also improve. We should hope that the original idea will pass the test of practice and that it will make it possible to reduce the size of acoustical systems.

The Physics Institute has not remained on the sidelines in regard to such an interesting subject as the directed medication transport (our newspaper reported on this on the 8th of September 1983). The idea is clear: Supply the medication directly to the affected organ, and side effects will be reduced and the doses can be made smaller. At first it appeared to the physicists that the problem is not too complicated. The Latvian scientists proposed to fill microcapsules whose size is commensurate with that of the blood cells with medication. The patient takes the "magnetic drug", and a magnet is placed against the affected spot. The capsules collect near the magnet. But the better the medics became acquainted with the new method the more were the physicists convinced as to the extent that they had overestimated their possibilities.

Let us assume, said the medics, that the magnetite in the magnetic liquids is chemically nontoxic. But will it not lead to blood clots? Furthermore, they are difficult to eliminate from the organism; the immune system of the organism attacks them and tries to direct them to the liver. And how will they affect the main filter of the organism? In a word, there are enough doubts. To clear them up, medics and microbiologists came to the aid of the physicists.

The most unexpected solutions are possible here. Namely, an idea that looked paradoxical at the first glance was born at the Physics Institute, where fruitful work on the creation of the microcapsules is being carried out. The idea was to dispense with the use of the microcapsules altogether. Or rather to try to use natural "containers". As it is known, blood contains erythrocytes, which contain the oxygen carrier hemoglobin. The institute people learned how to greatly increase the magnetic susceptibility of erythrocytes. And if one fills them with medicines in place of hemoglobin then the blood corpuscles can be utilized as natural containers.

It may appear that there are many more ideas regarding the use of magnetic liquids than there are embodied solutions. This is indeed partly so. But this situation should hardly bother us. It is rather a sign of the immaturity and indubitable promise of this direction.

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